NACE SP0116-2016
Item No. 21402

Standard Practice

Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines

Approved 2016-02-12
NACE International
15835 Park Ten Place
Houston, Texas 77084-5415
+1 (281) 228-6200

ISBN 1-57590-333-4

Foreword

This standard practice outlines a methodology to assess pipeline integrity because of the threat internal corrosion in onshore and offshore pipelines and other piping systems that normally carry multiphase fluids (gas, water, and oil) termed multiphase flow internal corrosion direct assessment (MP-ICDA). Liquid separators (drips), compressing stations, vessels, and other equipment not related to pipelines are not included in this standard. This standard applies to pipelines, both onshore and offshore, containing carbon dioxide (CO_2), hydrogen sulfide (H_2S), oxygen (O_2), and other corrosive species. Additionally, this standard applies to pipelines that continuously contain a liquid phase (water and condensate and/or oil and/or petroleum compounds), a possible solids content of various mineral scales, biofilms, or corrosion product compounds, and a continuous gas phase with fluid conditions that are not specifically covered by NACE SP0110[1] for wet gas internal corrosion direct assessment (WG-ICDA). Additionally, solids may be included as a phase by itself and may also be included in multiphase flow analysis of fluid streams. This standard is intended for use by pipeline operators, oil/gas producers (upstream), and other pipeline industry individuals who manage pipeline integrity (both onshore and offshore) for pipelines that are normally under multiphase loading conditions and are outside the scope of NACE SP0110,[1] NACE SP0206,[2] and NACE SP0208.[3]

The MP-ICDA methodology has been developed to meet the needs of pipeline operators and producers to assess the integrity of pipelines with respect to the internal corrosion threats posed by the fluids. MP-ICDA is a structured process that combines pre-assessment, indirect inspections, detailed examination, and post-assessment to evaluate the impact of predictable pipeline integrity threats such as internal corrosion. Specifically, the goal of MP-ICDA is to identify locations with the greatest likelihood of internal corrosion and its influencing factors, such as water content, flow regime, liquid hold-up, flow velocities, temperature and pressure changes. These locations are exposed and examined in accordance with criteria established in Section 4. The results of these examinations are used as a basis for assessing the condition and integrity of the remaining pipeline segments (those with less likelihood of corrosion). Direct assessment (DA) does not depend on the ability of a pipeline to undergo in-line inspection (ILI) by smart-pigging or pressure testing, making it most valuable to those pipelines unable to accept pigs or those that cannot be hydrostatically pressure tested. This standard is intended to provide an integrity assessment methodology for internal corrosion for pipelines where ILI cannot be performed; however, the MP-ICDA methodology may also serve, complement, or assist in those cases in which ILI was conducted or is contemplated to demonstrate the reliability of the ICDA process. It can also be used for optimizing the selection/justification, inspection frequency, or prioritization of pipelines that are subjected to ILI.

In multiphase flow systems, subregions of a pipeline that is identified within a region that are more susceptible to internal corrosion depend on the flow pattern that are defined by flow velocities, sudden changes of geometries, changes in elevation caused by the topography of the terrain, sharp elbows, expansions, changes in internal diameter and other changes that may influence the hydrodynamics of the flow. Multiphase flow and flow regimes can be determined by the use of flow models that have a hydrocarbon phase envelope (water and hydrocarbon), and the interaction between the gas and liquid phase, and allow the prediction under flowing conditions that shows local temperature, pressure, and fluid composition for a pipeline. Depending on the flow (i.e., velocity, gas/liquid quality, temperature, pressure, wall surface conditions, etc.), and specific operating conditions, the effects of flow regimes are considered. Flow regimes and flow hydrodynamic characteristics influence the threat of internal corrosion, and thus affect pipeline integrity.

The goal of MP-ICDA is to identify confirmatory or most probable locations (MPLs) along a pipeline subregion for determination of direct assessment sites. These sites are where internal corrosion damage has been identified by means of integrating available historical information in combination with the use of flow models to determine flow regimes and internal corrosion prediction models (ICPMs) that a company deems appropriate for its specific application to predict or calculate internal corrosion rates. The focus is the identification of conditions along the length of a pipeline region so that local subregion integrity threats with respect to internal corrosion are identified for prioritized damage assessment, repair, and mitigation. MP-ICDA emphasizes the identification of damage distribution on corrosion areas inside pipelines, and the corrosion rate prediction models can fit into the overall process by serving as tools to predict the corrosion rate at these locations and the estimation of wall losses within one flow pattern (e.g., stratified, slugging, annular, or mist) within a specific pipe region and/or subregion.

This standard was prepared by Task Group (TG) 426, "Internal Corrosion Direct Assessment for Multiphase Flow Pipelines." TG 426 is administered by Specific Technology Group (STG) 35, "Pipelines, Tanks, and Well Casings." This standard is issued by NACE International under the auspices of STG 35.

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.

NACE International
Standard Practice

Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines

Contents

Section 1: General

1.1 Introduction

1.1.1 This standard describes the NACE International internal corrosion direct assessment (ICDA) process for multiphase flow pipeline systems. It is intended to serve as a guide for applying the MP-ICDA process on multiphase flow pipeline systems that meet the feasibility requirements described in Paragraph 3.3.

1.1.2 The three primary purposes of the MP-ICDA method are to assess the integrity of a pipeline because of internal corrosion in multiphase flow pipelines, to identify the locations where pipeline integrity may be compromised, and determine the frequency of pipeline integrity assessment.

1.1.3 The MP-ICDA method assesses how the internal corrosion severity is distributed along the subregion. The methodology includes methods of examination available to a pipeline operator/producer to determine the occurrence, extent, and severity of internal corrosion.

1.1.4 MP-ICDA also provides a framework for the use of multiphase flow modeling results (e.g., flow velocities, temperature and pressure profiles, liquid hold-up, and flow patterns) in understanding the hydrodynamics of the flow along this pipeline segment and aids in understanding how these variables can affect internal corrosion.

1.1.5 MP-ICDA was developed for onshore and offshore multiphase flow pipelines that transport a combination of gas, water, solids, and/or crude oil or hydrocarbon liquids as part of normal operations. MP-ICDA is applicable to pipelines that transport multiphase flows including, but not limited to: gathering, producing pipelines, well lines, and flow lines. The basis of MP-ICDA is for pipelines, and consists of following the four types of the direct assessment methodology: pre-assessment, indirect inspection, detailed examination of selected locations, and post assessment.

1.1.6 One benefit of the MP-ICDA approach is that an assessment can be performed on a pipe segment for which alternative methods (e.g., ILI, hydrostatic testing, etc.) may be impractical.

1.1.7 MP-ICDA does have limitations, and not all pipelines can be successfully assessed using this method. These limitations are dependent on the specifics of each pipeline system and shall be identified in the pre-assessment step.

1.1.8 The provisions of this standard shall be applied by or under the direction of verifiably competent persons who, by reason of knowledge of the physical sciences and the principles of engineering and mathematics, acquired by education or related practical experience, are qualified to engage in the practice of corrosion control and corrosion risk-based assessment on multiphase pipeline systems. Such persons may be registered professional engineers with verifiable experience in internal corrosion for pipelines, certified as corrosion specialists or internal corrosion specialists by organizations such as NACE International, or professionals (e.g., scientists, engineers, or technologists) with professional experience including detection/mitigation and evaluation of internal corrosion in pipelines.

1.1.9 For accurate and correct application of this standard, all four steps shall be performed. Using or referring only to specific paragraphs or sections may lead to misinterpretation or misapplication of this standard.

1.1.10 In the process of applying MP-ICDA, while performing the detailed examination, other pipeline integrity threats such as external corrosion, mechanical damage, stress corrosion cracking (SCC), etc. may also be detected. When such threats are detected, additional detailed examination or inspections must be performed to ensure that pipeline integrity is not compromised, regardless of mechanism. This may require an external corrosion direct assessment (ECDA) or a stress corrosion cracking direct assessment (SCCDA).