



NACE MR0176-2020
Item No. MR0176-2020
Revised: 2020-08-27
Reaffirmed: 2012-06-05
Reaffirmed: 2006-03-11
Reaffirmed: 2000-03-28
Revised: October 1994
Approved: January 1976

Metallic Materials for Sucker-Rod Pumps for Corrosive Oilfield Environments

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 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 assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE interpretations issued by NACE in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this NACE 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 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 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CAUTIONARY NOTICE: NACE standards are subject to periodic review, and may be revised or withdrawn at any time in accordance with NACE technical committee procedures. NACE 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 standards may receive current information on all standards and other NACE publications by contacting the NACE *FirstService* Department, 15835 Park Ten Place, Houston, TX 77084-5145 (tel: +1 281-228-6200, email: firstservice@nace.org).

ABSTRACT

This standard specifies metallic material requirements for the construction of sucker-rod pumps for service in corrosive oilfield environments. American Petroleum Institute (API) Spec 11AX provides dimension requirements that ensure the interchangeability of component parts. However, that document does not provide material specifications or guidelines for the proper application of various API pumps. API RP 11AR lists the general advantages and disadvantages of the various pump types and lists the acceptable materials for barrels and plungers; API RP 11BR and NACE SP0195 supplement API Spec 11AX by providing corrosion control methods using chemical treatment. This standard is intended for end users (e.g., production engineers) and equipment manufacturers to supplement the use of the aforementioned API and NACE publications.

KEYWORDS

Sucker-rod pump, barrel, plunger, TG 084

Foreword

This standard specifies metallic material requirements for the construction of sucker-rod pumps for service in corrosive oilfield environments. American Petroleum Institute (API)⁽¹⁾ Spec 11AX¹ provides dimension requirements that ensure the interchangeability of component parts. However, that document does not provide material specifications or guidelines for the proper application of various API pumps. API RP 11AR² does list the general advantages and disadvantages of the various pump types and lists the acceptable materials for barrels and plungers; API RP 11BR³ and NACE SP0195⁴ supplement API Spec 11AX by providing corrosion control methods using chemical treatment. This standard is intended for end users (e.g., production engineers) and equipment manufacturers to supplement the use of the aforementioned API and NACE publications.

This standard was originally published in 1976 and was revised in 1994 by NACE Task Group T-1F-15 on Sucker-Rod Pumps for Corrosive Environments, a component of Unit Committee T-1F, "Metallurgy of Oilfield Equipment." It was reviewed by Task Group T-1F-28 and reaffirmed by T-1F in 2000, and was reaffirmed in 2006 and 2012 by Specific Technology Group (STG) 32, "Oil and Gas Production—Metallurgy." It was revised in 2020 by TG 084, "Metallic Materials for Sucker-Rod Pumps for Corrosive Oilfield Environments." This standard is issued by NACE International under the auspices of STG 32.

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.

⁽¹⁾ American Petroleum Institute (API), 1220 L St. NW, Washington, DC 20005-4070.

NACE International Material Requirements (MR0176-2020)

Metallic Materials for Sucker-Rod Pumps for Corrosive Oilfield Environments

1. General	4
2. Description of Tables	4
3. Barrel Selection	5
4. Maintenance Record System	6
References	14
Appendix A: Pump Selection (Nonmandatory)	15
Appendix B: Economic Benefits (Nonmandatory)	15
Appendix C: Case-Hardening Processes for Steel Pump Barrels for a Corrosive Environment (Nonmandatory)	16

TABLES

Table 1: Classification of Metal-Loss Corrosion for Sucker-Rod Pumps	7
Table 2: Recommended Materials for Mild Metal-Loss Corrosion Environments	7
Table 3: Recommended Materials for Moderate Metal-Loss Corrosion Environments	8
Table 4: Recommended Materials for Severe Metal-Loss Corrosion Environments	9
Table 5: Typical Mechanical Properties of Pump Barrel Materials	10-11
Table 6: Typical Mechanical Properties of Plunger Materials	12
Table 6.1: Typical Chemical Composition of Spray Metal	13
Table 7: Typical Materials for Cages	13
Table 8: Typical Materials for Pull Tube, Valve Rod, and Fittings	13
Table 9: Typical Composition and Hardness of Cast Cobalt Alloys Used for Valve Parts	14
Table 10: Typical Composition and Hardness of Sintered Carbides Used for Valve Parts	14

Section 1: General

- 1.1 An adequate chemical treatment program using a selection of proper corrosion inhibitors and application techniques is necessary for optimum performance of sucker-rod pumping equipment in a corrosive environment. However, the optimal solution to control the direct attack in pump materials consists of a combination of materials selection with chemical treatment, especially in those cases where the inhibitor is inefficient, and the material is exposed to the environment. The optimal combination will be based upon field experience, economic evaluation and expected mean time between failures (MTBF).
- 1.2 The recommended materials in this standard are presented in tables and listed in order of preferred usage in six different environments with varying degrees of corrosiveness and with and without possible abrasion. The listed materials have performed satisfactorily when used in the specified environments. These material recommendations are based on field experience.
- 1.3 This standard is not intended to preclude the development and testing of new materials that might improve sucker-rod pump performance. It is the responsibility of the user to fully evaluate the performance of any new material prior to its use.
- 1.4 The designations and mechanical properties of the materials covered by this standard are listed in selected tables.
- 1.5 Selection of materials will depend on the type of pump chosen for the application as outlined in Appendix A (Nonmandatory).

Section 2: Description of Tables

- 2.1 The specific quantities of water, hydrogen sulfide (H_2S), and carbon dioxide (CO_2) that are used to classify the corrosiveness of a fluid as mild, moderate, or severe are detailed in Table 1.
 - 2.1.1 Explanations of the mild, moderate, and severe metal-loss corrosion classifications provided in Table 1 are intended to be a guide for the user. Currently, there is no clear consensus on which combination of produced fluids constitutes mild, moderate, or severe corrosive environments for subsurface pumps. There can be amounts of H_2S , CO_2 , and water that do not clearly fall into one of the three combinations. The user's operating experiences coupled with analysis of failures should be used to develop the appropriate classification.
 - 2.1.2 The three corrosion classifications are identified by amounts of water, H_2S , and CO_2 in the produced fluids. There are other constituents in the fluid that can influence corrosion. General comments on these constituents follow:
 - 2.1.2.1 Oxygen—Oxygen can be very destructive to the system. If oxygen is discovered, every attempt should be made to free the system of oxygen, or at least bring it to below 20 ppb dissolved oxygen. Severe corrosion can be expected above 50 ppb dissolved oxygen.
 - 2.1.2.2 Chlorides—High concentrations of chlorides can lead to pitting corrosion. Risk of chloride-induced pitting corrosion on pump parts should be assumed to exist when the total dissolved solids exceed 10,000 mg/L (0.0835 lb/gal) and/or total chlorides exceed 6,000 mg/L (0.05 lb/gal).
 - 2.1.2.3 H_2S (Sour Service)—Sour service conditions should be assumed to exist when H_2S is present in the system at partial pressures equal to or greater than 0.35 kPa absolute (0.050 psia). When operating in sour service, the material for subsurface pump fittings (connectors, bushings, etc.) should conform to the requirements of NACE MR0175/ISO 15156.⁵
 - 2.1.2.4 Water Content—Generally, if the water content is greater than 20%, the fluid exists as a water phase with oil droplets. If the water content is less than 20%, an oil phase with water droplets can exist. Inhibitors should be used if the water content is greater than 20%.
 - 2.1.2.5 Temperature—The higher the temperature, the greater the rate of corrosion.
 - 2.1.2.6 pH—The pH at bottomhole conditions is frequently lower (more acidic) than that measured at the surface. During acidizing, the pH should be monitored to ensure that the fluid does not attack chrome plate if chrome plate is used in the pump. Even low concentrations of acidizing can attack and affect the chrome plate over time.