

# Metallic Materials for Sucker-Rod Pumps for Corrosive Oilfield Environments

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## 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)<sup>(1)</sup> Spec 11AX<sup>1</sup> 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<sup>2</sup> does list the general advantages and disadvantages of the various pump types and lists the acceptable materials for barrels and plungers; API RP 11BR<sup>3</sup> and NACE SP0195<sup>4</sup> 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.

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

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## 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.<sup>5</sup>
    - 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.