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Guidance on Practice for Corrosion Protection During Hydrotesting

GP 06-29

BP GROUP
ENGINEERING TECHNICAL PRACTICES

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Introduction

Before new or rehabilitated pressure containing equipment is placed into service, it is a normal procedure to test it for integrity at a pressure above its designed working pressure.

The testing medium may be clean fresh water, potable water, 60/40% water/glycol, treated inhibited sea water, oils, air, or inert gases. Typically hydraulic oil and instrument air systems should only be tested using the specified operating medium.

Water is the most used testing medium in hydrostatic testing and it comes from one of several sources: aquifers, rivers, ponds, sea, etc. The use of water from any of these sources can cause corrosion and introduction of bacteria into the equipment. The severity of the problem is dependent upon the type and quality of the water used, the length of time the water remains in the equipment, the temperature, and the metallic material of which the equipment is made.

Chemicals are normally used to mitigate and prevent corrosion damage during the period of water presence inside the equipment.

This document deals with the corrosion control during hydrotesting when water is used as the test medium.



1. Scope

This GP provides guidance on corrosion mitigation and prevention during the hydrotest operations and water presence in the equipment. This technical engineering practice is applicable to all equipment hydrostatically tested using water as test medium and made totally or in part by metallic materials.

Other materials, beside metallic materials, and other test media, beside water, are out of the scope of this document.

2. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:

Aerobic bacteria

Bacteria that grow in presence of air or uncombined oxygen.

Anaerobic bacteria

Bacteria that grow in absence of air or uncombined oxygen.

Biofilm

The collection of sessile organisms combined with the deposits formed by microbial growth.

Brackish water

Brackish water is water that is saltier than fresh water, but not as salty as sea water. It may result from mixing of seawater with fresh water, as in estuaries, or it may occur naturally, as in brackish fossil aquifers. Technically, brackish water contains between 0,5 and 30 grams of salt per litre—more often expressed as 0,5 to 30 parts per thousand (ppt or ‰).

Sessile bacteria

Bacteria that grow on and lie attached to a surface.

Planktonic bacteria

Bacteria that are found in the water and their movement is controlled by the movement of water.

3. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

ARB – Acid Reducing Bacteria

CRA – Corrosion Resistant Alloy

MIC – Microbiologically induced corrosion

SRB – Sulphate Reducing Bacteria

4. General

Water from most sources contains oxygen and living organisms of different types. Among the latter, bacteria are present in almost all types of water. Both oxygen and bacteria may become a cause of corrosion damage to metallic materials during the water presence in the equipment.



- a. Measures shall be taken so that the integrity of the equipment tested is not harmed.
- b. Measures taken should address two possibilities.
 1. Corrosion damage that occurs during the water presence in the equipment.
 2. Corrosion that initiates in this period and continues during the equipment service life.
- c. As a base case the water used for hydrotesting shall be treated with the following chemicals: biocide and oxygen scavenger. In case of deviation from the above the efficacy of the treatment shall be demonstrated by testing and shall be approved by the Engineering Authority.
- d. When deciding the type of treatment, the cost of the corrosion mitigation measures should be compared to the cost and the consequences of an eventual failure or degradation of the equipment and the probability that such damage may occur. The type of treatment shall be decided according to the results of the life cycle cost evaluation and of the risk analysis.
- e. Hydrotest procedure, including corrosion mitigation, shall be approved by the project or BU corrosion Technical Authority.

5. Corrosion threats

Natural waters, like fresh, river, brackish, and sea water contain oxygen and different amounts of bacteria. While the equipment is filled with water it is subject mainly to two types of corrosion:

- *Oxygen corrosion.*
- *Microbiologically induced corrosion (MIC).*

5.1. Oxygen corrosion

This mechanism is always present if oxygen is present in the water, but it is not generally a serious threat in carbon steel equipment (in closed systems) and when the ratio of water volume to exposed steel surface area is relatively low – as in the case of pipelines – because the oxygen is rapidly depleted due to the reaction with the pipe wall. Tests indicate that corrosion due to oxygen content, even with saturated waters, is usually minimal in a closed carbon steel pipeline and major problems rarely result from this mechanism.

- a. Corrosion damage due to oxygen corrosion may act as initiation sites for other corrosion forms during the service life of the equipment or may generate iron oxide scales that may cause downstream problems and measures should be taken to avoid such damage.
- b. The impact of hydrotest water on stainless steels shall be assessed before flooding of the equipment.

Several stainless steels may undergo severe localized corrosion in oxygen rich and/or high salinity waters.

- c. Oxygen removal should be performed by physical or chemical (oxygen scavenger) means before the introduction of water in the equipment.

Removal of oxygen is the principal method of prevention for this corrosion threat.

- d. Oxygen scavenger shall be injected in a location where there is no contact with air and contact of water with air shall be avoided downstream the injection point. The formation of pockets of air in the equipment shall be avoided.

