Pre-Startup Corrosion Prevention: Hydrotesting

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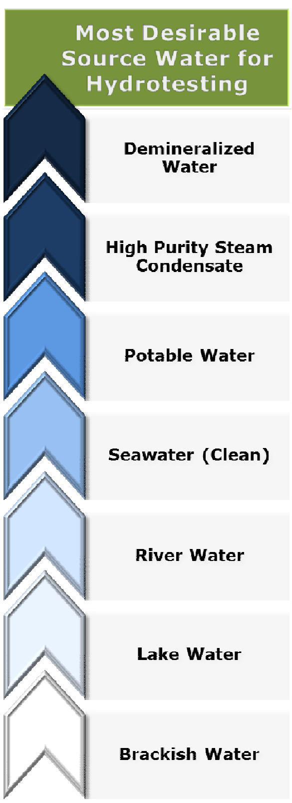

Figure 1: General Ranking of Water Sources for use in Hydrostatic Testing

Hydrotesting of pipelines and equipment, including tanks and vessels, is a key part of ensuring that they are fit for purpose depending on factors such as contact time, chemicals used, oxygen and bacteria. This may result in general corrosion, crevice corrosion, pitting corrosion, differential aeration corrosion or microbially induced corrosion (MIC). MIC will take place due to the introduction of bacteria during the hydrotesting and/or parking of equipment. Corrosion caused by any one or combination of these mechanisms may reduce pipeline and equipment service life and in extreme cases make it unfit for purpose.

Source Water & Filtration

The source water selected for use in hydrotesting should be the least contaminated by chemicals and solids (both dissolved and not dissolved) that is readily available in sufficient quantities. Figure 1 shows the general ranking of water sources for use in hydrostatic testing.

The large concentrations of bacteria and contaminants present in brackish water will require careful analysis before hydrotest water treatment recommendations may be made. River and lake waters are typically not used for deepwater hydrotesting. Seawater should be sourced from a location free from external contamination that is more than 50ft above the seabed and 50ft below the sea surface. Where this is not possible, then the water should be treated as brackish. Bacteria should be considered to be present in all raw water sources.

Chloride Content

There is no maximum allowable chloride content for carbon steels. However, the lowest chloride content water source available (i.e. conforming to other water quality requirements) should be used.

The maximum allowable chloride content for stainless steels and nickel based alloys is 100ppm. However, higher chloride content waters are permissible in cases with no viable economic alternative (e.g. pipelines with a high internal volume dictating the need for seawater as a hydrotest fluid). Chemical treatment is always required for high chloride content waters in contact with corrosion resistant alloys (CRAs).

Oxygen Content

For deepwater situations, oxygen content away from the surface is generally constant. The oxygen content of the hydrotest water should not normally influence selection of which water source to use.

Water Temperature

If there is a possibility that the temperature of the hydrotest fluid will fall to 32ºF or lower during testing or storage, glycol or an alternative antifreeze should be added to the hydrotest water. If glycol is used, it should be at a solution concentration of 60% or greater to inhibit microbial corrosion processes.

High water temperatures will increase growth of bacteria and MIC.

Use of Preservation Fluids

The item of equipment to be protected may be filled with a fluid that is designed to prevent corrosion of the internal surfaces, either due to its inactivity or through the presence of additive chemicals specifically designed to prevent corrosion from taking place.

Adequate measures should be taken to allow for expansion and contraction of the preservation fluid with temperature variations.

1. Hydraulic Fluids - These may be either water or mineral oil-based (i.e. petroleum derived). Vegetable oils should not be used. A compatible biocide should be added to the hydraulic fluid to control bacterial populations and corrosion.

2. Diesel Oil - The equipment should be thoroughly dried to remove all traces of water. Some water will often be present in the diesel, and corrosion-inducing bacteria may also be present. A compatible biocide, such as glutaraldehyde, should be added to the diesel to control bacterial populations and corrosion.

3. Storage Fluid - These are often of a similar composition to hydraulic fluid, but may have additional chemical additions to accommodate limited mixing with water. They are typically buffered to a high pH to mitigate corrosion and may also contain additional liquid and vapor-phase corrosion inhibitors.

4. Glycol – This may be used as a long-term storage fluid due to its corrosion inhibition properties. It should be used at a concentration of 60% or greater to ensure that microbiologically-induced corrosion is inhibited. At lower concentrations it is possible for certain types of bacteria to use glycol as a metabolite, ultimately resulting in the risk of MIC.

Chemical Treatment of Fluids

Fluids introduced to hydrotest equipment and pipelines should be treated with chemical additives (biocide and, depending on specific exposure conditions, corrosion inhibitor and/or oxygen scavenger) at the required concentrations to control corrosion where the fluid will remain within the equipment until the planned commissioning date. The choice of chemicals depends on a multitude of factors such as exposure time, conditions, etc.

Chemical additives will need to be compatible with their exposure environment and other additives or fluids, and added to the fluid in a concentration that compensates for foreseeable mixing with any untreated fluids, such as seawater ingress.

Requirements for treatment by material are given in Figure 2.

The cost of chemical treatment of fluids to be used in hydrotesting and their subsequent disposal can be significant. It is, therefore, better to avoid the use of treatment chemicals. This may be achieved through three methods:

1. Keeping the length of exposure time of the equipment to the fluid to an acceptable period.

2. Draining the equipment after hydrotesting such that it is dry and no significant corrosion may take place.

3. If complete drainage does not occur, some geometries can be entered and dried by hand using towels and sponges.

Thought should be given during design to drainage of the equipment. If a particular design makes drainage more likely than another, the option with complete drainage should be chosen. Hydrostatic test fluids containing residual levels of biocide and other chemicals will need to be disposed of in accordance with the pertinent country, local, state and/or federal regulations.

Hydrotesting Treatment Standards

At this time, there are no standards for treatment of hydrotest fluids. Currently, GATE is heading a NACE committee to develop a standard way for treating hydrotest fluids to prevent pre-startup corrosion.

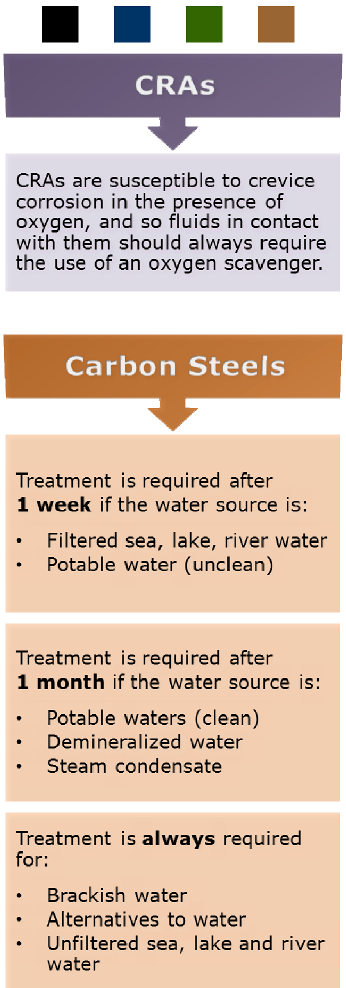

Figure 2: Treatment Requirements by Material