LEAK DETECTION FLUIDS CYLINDER PACKAGES

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1 Introduction and Scope

Over the years leak detection techniques have varied from the use of a single application of “soap-based” solutions for coarse leaks to the highly sophisticated use of a mass spectrometer, which can detect leaks at the ppb level. In the context of the present application to gas cylinder / valve package, the use of specialized leak detection fluids (LDFs) will be developed further. These specialized LDFs are far superior to household soap based solutions, which could contain contaminants or other detrimental constituents. As such, household soap based solutions should not be used.

There are various national regulations and international guidelines to ensure that cylinders and valves are checked for gas tightness. Though such a post-fill check is an essential part of a quality control procedure to ensure that customers receive a non-leaking package, the choice of the LDF needs to be carefully considered because of potential hazards from LDFs. These potential hazards include stress corrosion cracking (SCC) and incompatibility with materials and ladings such as oxygen.

2 Types of Leak Detection Materials

For the purposes of this publication, leak detection materials are referred to as LDFs. These materials can include foams as well as liquids. They include detergent-based liquids, and liquids packaged with propellants for aerosol application. Whatever material(s) is selected, it must be assured that the final packaged LDF meets the criteria and considerations to satisfy the specific application.

3 Using a Leak Detection Fluid

A method commonly used for general leak testing procedures is to either apply an LDF by means of a brush to joints and other potential leakage points, or by spraying a LDF at the required points on the cylinder/valve package.

The LDF solutions range from something as simple as a detergent to more sophisticated proprietary compounds supplied in aerosol cans. Often the manual application route uses a diluted solution to avoid some of the hazards (see Section 4) associated with LDFs. It is essential to thoroughly stir the diluted solution to avoid variation in strength during use.

While the detergent-based LDFs are frequently used effectively in bulk applications, proprietary compounds have benefits for applications requiring ease of transportation.

4 LDFS – Potential Hazards

There are a number of potential hazards involved in the use of LDFs. These range from:

- LDFs damaging both the cylinder or valve materials;
- LDFs posing potential flammability risks, especially with oxygen.

4.1 LDFs—materials compatibility

Depending on the chemical constituents of any particular LDF, the overall question of materials compatibility needs to be considered. One of the possible constituents of LDFs is the ammonium radical. The latter compound, in association with oxygen and water, is frequently responsible for SCC (Figure 1) of copper-based alloys such as brass and aluminum silicon bronze, which are often used for manufacturing cylinder valves. Ammonia can be introduced into LDFs by third parties who repackage LDF into aerosol cans. The original manufacturer of the LDF may be unaware of this contamination.

The corrosive effects from certain LDFs coupled with the stresses to which a cylinder valve is subjected due to mechanically applied forces, residual stresses, and gas pressure can be sufficient to result in SCC.

It is difficult to be precise with a high level of confidence about the minimum amount of ammonia needed to trigger this mechanism, but it has been known that moisture films on brass surfaces are capable of dissolving residual ammonia from atmospheric contamination, resulting in SCC.

Of further consideration is the possible presence of halide ions (usually chloride) in LDFs. Though not necessarily harmful to steel or brass surfaces, they do cause significant damage to aluminum alloy cylinders in the form of pitting. Excessive exposure to chloride ions in the form of sea-water (e.g. diving cylinders) to certain aluminum alloys (e.g. AA2001) has been disastrous if the alloy has not been heat-treated correctly. Even cylinders made from the much more corrosion resistant alloys of the AA6000 series have been pitted on the top surface of the cylinder's neck after successive applications of certain LDFs.

4.2 LDFs - oxygen / flammability risks

The repeated action of application and subsequent drying of an LDF (as described in Section 2) is one of the causes of an ignition in an oxygen environment. This is especially true if the LDF is made from a household soap-based solution that could contain mineral oil, vegetable oil, or fatty acids. This is due to the progressive accumulation of residues, especially in the valve outlet where the LDF is introduced to check for seal integrity. This is because subsequent use of the valve will expose this residue to a high-pressure gas stream (oxygen).

These operational findings have been confirmed in the laboratory using an "oxygen bomb" testing equipment. The results for many commercially marketed LDFs sold as "safe for oxygen," "oxygen safe" etc. have shown that in every case their dried residues were easy to ignite in high-pressure gaseous oxygen or liquid oxygen.

5 Recommendations

It is difficult to make a specific recommendation for a choice of LDF. Users need to decide which LDF is best suited for the application. The following are some general recommendations when deciding which LDF to choose:

- Avoid using LDFs that contain ammonia / ammonium radicals. Ammonia can be introduced into LDFs by third parties who repackage LDF into aerosol cans.
- Avoid using LDFs that can cause SCC. For example, ASTM G188, *Standard Specification for Leak Detector Solutions Intended for Use on Brasses and Other Copper Alloys*, and ASTM G186, *Standard Test Method for Determining Whether Gas-Leak-Detector Fluid Solutions Can Cause Stress Corrosion Cracking of Brass Alloys*, provide a means to evaluate LDFs for potential to cause SCC in brass and copper alloys .
- Select an LDF having a residue with an auto-ignition temperature (as measured using an oxygen environment), which is compatible with the intended application. For example, MIL-PRF-25567, *Performance Specification: Leak Detection Compounds, Oxygen Systems*, provides a means to evaluate LDFs for compatibility with oxygen and other oxidizers including residues.
- Avoid using LDFs that contain halide ions especially in conjunction with aluminum-alloy cylinders.
- Use the most diluted solution of an LDF consistent with the method of application and the manufacturer's recommendation.
- Avoid corrosive LDFs (e.g., acids and bases).
- Consider the potential hazards to the environment and personal exposure when choosing LDFs.

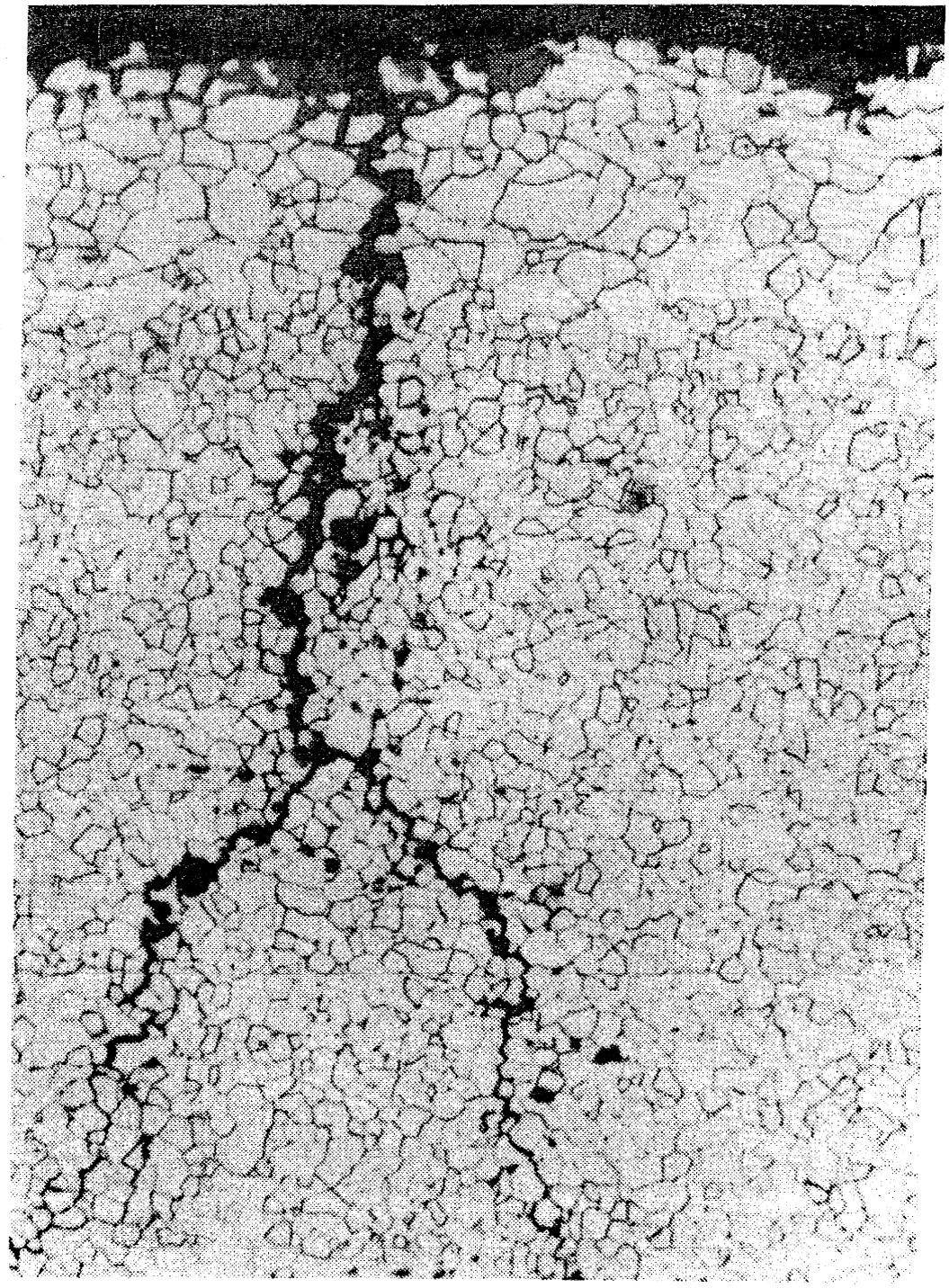

Figure 1 - Stress Corrosion Cracking of a brass valve