

# THE ART OF LEAK TESTING

# **INTRODUCTION**

**Finding leaks on an industrial package or system can be one of the most difficult and frustrating jobs that can face a technician. A multitude of products are offered on the market that claim to simplify this problem but experience tells us there is no one product or method that fits all the possibilities that can be encountered in reality. Perhaps the technician should first spend time determining what kind of leakage is being looked for and what are the methodologies and products are available to determine whether a leak is present or not. There are also some serious limitations that can make leak detection difficult on refrigeration equipment that need to be considered as well. The presence of insulation, area classifications, environmental considerations, and the refrigerants involved all contribute to complicate what should seem to be a simple task. Some of the pros and cons of the different approaches, methods and products available are reviewed below.**

## **Soap Bubbles**

**Soap bubble testing is one of the most reliable methods available for finding most leaks. Either commercially available leak detection fluid or regular dish detergent ( Joy performs best) can be used. The commercial fluids are expensive compared to making your own but have the benefit of being suitable for use below 32 °F. These fluids often also contain a paraffin-like base which will preserve bubble nests long after the fluid has drained away or evaporated. Very minute leaks can be captured using homemade bubble soap by adding a teaspoon of glycerin to one pint of soap and water solution. While the glycerin is not as effective as the commercial fluids, bubble nests will persist for up to an hour depending on the temperature.**

**Soap bubble fluid can be squirted on the area to be tested, poured on the area, or gently brushed on. This method is most suitable for finding weld leaks, porosity in castings, and tube to tube sheet leaks. It can also be used just about anywhere you can get a visual observation after making the application. Leaks can also be verified inside tubes by using a plug in one end of the tube and holding or lightly inserting a plug in the other end to partially block the opening. The application of bubble soap around the lightly seated plug will reveal bubbles if leakage is present. Bubble testing is time consuming and messy but extremely effective particularly in finding very small leaks where they can be visually observed.**

**Soap bubbles obviously are not suitable for finding leaks under insulation or in areas where a good fluid seal cannot be obtained such as around large flanges or valves. Similarly, if the surfaces are too hot or too cold, bubble testing is probably not the best approach.**

## **Electronic Detectors (sniffers)**

**Electronic detectors are widely used and are useful up to a point. The electronic detector may get the technician close enough to the location of the leak**

That other methods of specifically locating the leak can be used most effectively. The problem with electronic detectors is the low threshold they require to alarm means a large area can be saturated relatively quickly resulting in a continuous indication. Some detectors also use heated elements and this may not be permissible in some areas because of the possibility of explosive vapors being present. Some detectors also become saturated relatively quickly and require constant threshold readjustment that may be fine in a saturated area but a limitation elsewhere if they are not cleared, where the concentration may be lower. Gases and chemicals other than the refrigerant you are looking for can also effect the sensors of electronic leak detectors. Many detectors will alarm on fork lift or diesel engine exhaust fumes or in the presence of other chemicals. Typically, a leak supposedly identified by an electronic detector should be confirmed by some other method, such as soap bubbles.

Halogen leak detectors can also alarm in the presence of foam insulation as often the foam was manufactured using a halocarbon refrigerant to create the closed cell foam. Moisture also seems to attract halocarbon vapors so that moist areas may generate an alarm simply because leaking vapors passed over the moisture and left a residual trace.

In cases where equipment is located outside or in areas with substantial air movement, vapor sensing devices are of limited use. In cold rooms or other confined areas the accumulation of vapors will reduce the device's ability to discriminate between a leak and the contaminated air in the space.

Where electronic detectors are useful is in providing an alert to the possibility of a leak and in identifying the general area the leak may be found. Once a potential leakage problem is identified other methods can be used to pinpoint the leak and assess the severity.

### **Halide Leak Detectors**

The halide leak detector is a simple version of a "sniffer" device. The principle of operation is relatively simple. The halide detector uses a propane flame to heat a copper element. An opening below the flame draws in air from a short length of hose that permits control of the source of the air allowing the technician to precisely draw samples from specific areas. When halogen molecules pass over the red hot copper the chemicals break down releasing the chlorine or fluorine components that will then turn the flame from blue to green.

The halide torch suffers many of the drawbacks of the electronic leak detector with the additional hazard of the open flame. The copper element can also be badly contaminated and continue to generate a green flame even after it has been removed to clean air after being exposed to high concentrations of refrigerant. And, because of the high temperature the subsequent products of combustion are probably best avoided. If a white smoke is generated by the torch, it is an indication the concentration of refrigerant in the air is very high. These fumes should not be inhaled and the use of the torch in such an environment is not beneficial or healthy.

## **Dye Additives**

**Dye additives are often used to provide an indication of leakage. Some additives are simple color additives that alert the observer to the location of a leak. The problem with dyes is that they concentrate in the oil charge and where there is some seal leakage on an open drive unit the dyes leave a considerable mess that seems to spread everywhere unless cleaned up. Dyes that only show up under ultraviolet do not make such an obvious mess but over time the stains spread until it becomes difficult to discern a new leak from an old stain.**

**Additives also pose a potential contamination problem and may evidence compatibility problems with different lubricants and refrigerants. While likely suitable for unitary applications the dye approach is not as suitable for large systems because of the large quantity necessary and the difficulty distributing the material through the system. The most serious leaks moreover are generally on the high side and even systems charged with dye have failed to leave a trace at a high-pressure vapor leak.**

**Once dye has been added to the system there is no easy or economical way to remove it. Even after several oil changes residual dye will remain. In the end it is just as easy to look for that tell tale oil leak that indicates a problem.**

## **Standing Hold Test**

**A standing hold test is another method of determining if a system has a leak. The standing hold method is subject to changes in pressure due to temperature changes ( if dry nitrogen is used the changes are small). The major limitation on the standing hold test is that while a small volume system may respond relatively quickly with even a small leak, a large volume system might require several days to evidence a change in pressure. Most gauges are only accurate within one or two psig so until there is a relatively large change that can be interpreted as a leak, more time has been lost. Additionally, this approach just indicates a leak but does not identify where the leak is located.**

**The standing leak test is useful to indicate if you have a leak in a hidden part of the system. Leaks in shell and tube exchanges, oil coolers, or other locations that cannot be leak checked easily may be indicated by such a test making it worthwhile to open the exchangers.**

## **Vacuum Hold Test**

**A vacuum hold test may be used instead of a pressure hold test and will likely show indication of a leak much quicker than the pressure hold test if using equipment that measures in microns. The problem with a vacuum hold test on equipment that has already been in service is that residual refrigerant in the oil may continue to off gas for a considerable period of time giving a false indication of a leak. Additionally if there is a leak, the leak will allow contaminants such as moisture into the system.**

## **Ultrasonic Leak Detection**

**Ultrasonic leak detectors depend on the noise generated by the turbulence of a rapidly escaping fluid as a means of locating the leak. Ultrasonic detectors work but have several drawbacks. In a noisy environment Ultrasonic waves are generated as well and can make it difficult to locate a leak. In the outdoors, just the wind blowing across the head of the probe can generate noise. The pressure differential across the leak port and the size of the leak also effect the performance of the detector. A high-pressure leak will generate more noise at a higher intensity than a small leak or low-pressure differential. Where and ultrasonic detector can be useful is in situations where piping is behind walls or under a concrete slab. In these situations the leak cannot be seen and the only available means of detection would be by means of sound.**

### **Other means of finding leaks**

**Some of the most difficult leaks to find are hidden leaks. Tube leaks in shell and tube vessels, weeping relief valves, and purgers can be sources of continuous and intermittent leaks. Shell and tube vessel leaks are generally one of two types, tube to tubesheet or through the tube wall. Soap and glycerin can be easily and effectively used to check for tube to tubesheet leaks. Leaks in tube walls cannot be seen and it is only possible to check each tube by plugging both sides with rubber or cork plugs and waiting to see which plugs pop out.**

**Relief valve leakage can be checked by covering the valve outlet with a plastic bag and wait and see if the bag inflates. Where reliefs are headered it may be necessary disconnect the safeties one at a time to check them.**

**Malfunctioning purgers can vent considerable refrigerant in a short period of time. Both manual and automatic purgers should be constantly supervised when their air vent lines are left open.**

### **Locating the Leak**

**When a general survey of a system fails to reveal any leaks but the gradual loss of charge or accumulation of non-condensables indicates there is leakage somewhere the only choice is to resort to isolating sections of the system in the hopes of eliminating non-leaking sections. This approach can work well where it is possible to pump the system down and use pressure testing and hold techniques to narrow down the affected area. When testing it is important to remember that some leaks may only leak in one direction. Cracks in low-pressure suction piping have been found that leak air in but fail to leak pressure out when pressure tested. Some valve packings can behave in a similar fashion.**

### **Summary**

**The different means of leak detection provide a toolbox to be used by the technician in creating a strategy for leak detection and identification.**