Bullseye Leak Detector

Training

Advantages of CO_2 Leak Detection

by Bernie Thompson

Types of A/C leak detection
Dealing with diminished performance from air conditioning systems can be very frustrating. Additionally, root cause analysis can be difficult and time-consuming.

The first failure mode, and perhaps the most common, that should be evaluated, is a loss of refrigerant. Air conditioning system leaks can be very difficult and aggravating to locate due to the typically very small nature of these type leaks. In general a leak in an air conditioning system is smaller than four ten thousandth of an inch (.0004) and can be as small as one hundred thousandth of an inch (.00001). These extremely small leak sizes result in very small volume losses of refrigerant which create problems when trying to locate the site of the leak. Even these minute leaks result in refrigerant loss over a long period of time that will eventually affect the performance of the air conditioning system. To determine if a refrigerant leak is the source of the poor performance of the system, check the running pressure of the system; if it is below specifications, chances are that a leak is present.

If a leak is identified as the performance issue, identifying the location of these small leaks is challenged by the limited amount of gas escaping in a short period of time during your investigation. When scanning the A/C system with an electronic leak detector you will only be in front of the leak site for a time of about 1-2 seconds. For example, if the system is losing 28 Grams Per Year (GPY), that would equal 31,536,000 second in a year so 28 GPY/31,536,000 Seconds = .0000008 grams lost per second. As you can see there is a very small amount of gas leaking in the time you are in front of the leak site. So only the minute amount of refrigerant that is lost during your investigation into the location of the leak site will be available for detection.

Many types of leak detection systems have been used over the years to find the location of refrigerant leaks. The most common types are; 1) electronic refrigerant leak detectors, 2) dyes that can be seen with the eye, 3) electronic ultrasonic detection, 4) soap solutions that will produce bubbles, and 5) hydrogen leak detection. These types of detection systems all have their pros and cons.

Electronic Refrigerant Leak Detection
There are many different types of electronic refrigerant leak detectors currently on the market. These leak detectors sample air flowing over an electronic sniffer that has been programed to identify specific gases. This system has been used effectively to locate the leak site location in many situations. Issues with this type of detection include false alerts produced from the detector and its inability to locate very small leaks, causing the leak site to be missed. The false alerts are the result of these electronic refrigerant detectors looking for multiple blends of refrigerant bases. Attempting to isolate several discrete refrigerant blends can confuse the detectors, triggering false alerts based on many other substances that contain chlorine and fluorine such as windshield wash fluid. In the situation where only a very small leak is present, Chlorofluorocarbons (CFCs) and Hydrofluorocarbons (HFCs) refrigerant molecules being utilized are made of very large chemical molecules that do not pass easily through small leak sizes. With limited amounts of the refrigerant escaping during the investigation, the smaller leak site locations can be missed. Additionally the electronic detectors are made so that once the leak site is found the detector must find the leak site again within 2 seconds. In order to accomplish this the detector cannot totally clear the refrigerant from it sensor so the detector is zeroed, thus losing sensitivity each time the refrigerant is found. This can be confusing to the service personal in that the detector seems to find the leak and then cannot relocate the leak site due to lessened sensitivity. Further compounding this issue on the low side of the air conditioner is that of the refrigerant pressure and ambient temperatures being very closely related to one another. Typical low-side pressures range between 30 – 100 psi depending on the temperature of the day. If the ambient temperature is 70 degrees then the low side pressure is also about 70 psi. With these low pressure variations between the A/C system and the ambient air pressure, less refrigerant will leak out of the leak site during the investigation. This will make the leak sites on the low pressure side more difficult to locate.

Refrigerant Dyes

Adding dye to the air conditioning system can be useful in detecting leak paths. There are many different types of refrigerant dyes currently on the market. There are dyes that can be seen with the unaided eye and those such as ultraviolet (UV) dyes that will need the correct light wave length in order to be visible. "Ultraviolet" means "beyond violet", violet being the color of the highest frequencies of visible light. Ultraviolet light has a higher frequency than violet light. UV light is electromagnetic radiation with a wavelength from 400nm to 10nm. Different substances glow at different wavelengths, so make sure the UV light you are using matches the UV substance. This is done by testing the dye with your UV light. If the UV light is the correct wavelength it will allow the dye to be fluorescent. These refrigerant dyes can work more effectively than electronic refrigerant leak detectors in many situations. The primary drawback of this process is that these dyes are carried by the refrigerant and lubricant within the air conditioning system which requires the system to be operated for some time in order for the dye to be moved throughout the system. Once the refrigerant dye is dispersed throughout the system and is present at the leak site, the dye must be able to pass through the leak in order to be detectable. Many small leaks do not allow sufficient volumes of refrigerant, lubricant, and dye to escape so as to be visible. Additionally if a leak site is located behind an object, the dye can quite easily be missed. Once again the air conditioning low side pressure of only 30 – 100 psi may make the dye slow to escape through the leak site or may not allow any dye to escape through the leak site.

Ultrasonic Leak Detectors

Many air conditioning system leaks create sonic energy as the gas is being released. There are several different types of ultrasonic leak detectors currently on the market that attempt to read this energy and identify the leak site. Small leaks are difficult to find with these types of detectors because they emit very low levels of sonic energy, resulting in a high percentage of missed leak sites. In order for these devices to work the leak must be emitting detectable levels of sonic energy and the detection probe must be passed directly into that energy path. Depending on the size and location of the leak, this can range from difficult to impossible to accomplish.

Soaps

Soaps are often used effectively to detect the source of the leak. Soap is based on chemical surfactants which are compounds that lower the surface tension (or inter-facial tension) between two liquids. This lower surface tension produces bubbles when the soap is placed over the leak site and the correct volume is leaking from such a site. There are several different types of soap solutions that are used for leak detection. Perhaps the most common is Mr. Bubbles. There are several problems with any soap based leak detection. The most obvious is if the leak size is very small, a very low volume is escaping from the leak site. This volume output can often be measured in Parts Per Million (PPM). This small volume trace does not induce sufficient energy to beapplied to the soap to create a pressure jump that would create a visible bubble. Additionally, large leaks will have such a high volume output that the surface tension is immediately broken, preventing the bubble from forming. This lack of bubble production creates a serious problem when trying to locate the leak site with this method of detection.

Hydrogen Leak Detection

By introducing hydrogen into the system, an electronic sniffer programmed to identify the presence of hydrogen molecules is used to identify leaks. To perform this type of detection, the refrigerant must be removed and a mixture of hydrogen and nitrogen is introduced into the air conditioning system. The typical concentration is a mixture of 5% hydrogen and 95% nitrogen and is referred to as N2H2. In a mixture of less than 5.7% hydrogen, the hydrogen will not be flammable. This method of leak detection is prone to several problems. With the trace gas being composed of 5% hydrogen and 95%
nitrogen, the escaping gas is severely diluted, thus allowing only 5% of the total volume that has escaped from the leak site to be detected. When the volume escaping from the leak is so very small anyway, and the percentage that is detectable is only 5% of the total leak volume, it is easy to understand why small leaks are not found with this style of detection. A second problem is that hydrogen is lighter than air. This means that when trying to find a leak in the evaporation core housing, the hydrogen goes up and out the vents in very small amounts making evaporative core leak detection all but impossible.

CO2 Leak Detection

The CO2 system is similar to the hydrogen leak detection system in that it introduces a new gas into the system. Then a specifically programmed sniffer is used to identify high concentrations of the CO2 molecule in the ambient air. The CO2 leak detection system is superior to any other leak detection method because it offers several significant advantages. When using a CO2 Leak Detector the refrigerant is removed from the air conditioning system and undiluted CO2 is introduced directly into the system. CO2 is an inert gas with a double bond, making this a truly system safe gas. CO2 is one of the
smallest molecules that has the advantage of being heavier than air, thus giving it the ability to fall. This propensity to drop facilitates leak detection. A specific example of this advantage is the identification of leaks in the evaporator core or core connections:

• charge the air conditioning system with CO2 and plug the evaporator condensation drain hose

• 30 - 60 minutes later the plug is removed from the drain hose and the electronic detector is held against the drain hose

• If a leak is present the CO_2 will fall to the bottom of the evaporator housing and collect in the condensation drain hose. This CO_2 that collected in the condensation drain hose will be sensed and set off the CO_2 alert, thus making it quite easy to find a leak in the evaporator core or core connections.

Since the CO_2 molecule is smaller than other automotive refrigerants, it will move through small leak sites with less resistance. Additionally the pressure when charging the air conditioning with CO_2 can be determined with a pressure regulator. By utilizing CO_2, both high and low sides of the air conditioning system can be safely pressurized up to 200 PSI; this is a great advantage that allows very small molecules under greater pressure to escape out of the leak site. With this higher volume of undiluted CO_2 escaping out of the leak site, any size leak from very small to very large can be detect
with the dedicated electronic CO_2 sniffer. Additionally since the detector is designed to only locate CO_2 there is no false detection. Since this method of leak detection does not have to provide the exact location of the leak site, but only the general area, the detector is not zeroed and thus the detector never loses any sensitivity.

When using any gas based electronic leak detector finding the exact location of the leak site can be difficult, especially if several connections or components are all located within a small area. Because higher concentrations of CO_2 can cause a specifically formulated foam to change color, pinpointing the source of the leak can be simplified. The foam is applied to the general area identified by the sniffer and any leaking CO_2 will change the color of the foam from a pinkish red color to yellow at the exact location of the leak site. Additionally if the leak volume is large the foam will not only change from pinkish red to yellow but will also produce bubble(s) at the leak site. The foam can correctly indicate the size of the leak site by how fast the foam changes color, how much of the foam changes color, and how many bubbles are formed.

Analyzing the many ways that leaks are detected is a good start to gaining a clear understanding of why CO_2 detection is a far better method. When you are serious about accurately finding the leaks in air conditioning systems, and you cannot afford the time and money for a comeback, it is clear that CO_2 detection is the answer.