Advantages of Using a CO2 Leak Detector for AC systems

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 that should be evaluated, because it is perhaps the most common, 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 five ten thousandth of an inch (.0005) and can be as smaller than 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 an issue, identifying the location of these small leaks is challenged by the limited amount of gas escaping in a short period of time. Only the very small amount of refrigerant 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, 5) hydrogen leak detection 6) carbon dioxide leak detection. These type 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 or false positive detection produced from the detector and its inability to locate very small leaks, thus causing the leak site to be missed. The false positive detections are the result of these electronic refrigerant detectors looking for multiple blends of refrigerant bases. Additionally these detectors must be programmed to clear the detected refrigerant and then be ready to retest the leak site. Once the refrigerant is within the detector it cannot clear all of the refrigerant, so in order to be able to retest the leak site right away the detector auto scales.
This mean the detector losses some sensitivity.

Attempting to isolate several discrete refrigerant blends can confuse the detectors, triggering false positive alerts. In the situation where only a very small leak is present, Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), and Hydrofluorocarbons (HFCs) refrigerant molecules being utilized are made of very large chemical chains that do not pass through small leak sizes very easily. With limited amounts of the refrigerant escaping during the investigation the smaller leak site locations can be missed. Further compounding this issue on the low side of the air conditioner is the issue of the refrigerant pressure and ambient temperatures being very close to one another. Typical low-side pressures range between 30 PSI to 100 PSI depending on the ambient temperature. If the day time temperature is 70 deg., the low side pressure will only be about 70 psi. With these low pressure variations between the A/C system and the ambient air, less refrigerant will leak out of the leak site making low side leaks much harder to identify.

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 dyes that will need the correct light wave length to be visible. 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 site of the leak, the dye must be able to pass through the leak 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 30 – 100 psi will make the dye slow to leak or may not leak at all.

Ultrasonic Leak Detectors

Sound is based on a vibration that propagates as a typically audible mechanical wave of pressure and displacement, through such medium such as air or water. As a leak site vibrates the air, the vibrations propagate away from the leak source at the speed of sound, thus forming the sound wave. The particles of air do not travel with the sound wave but allow the vibration to move through the particles in the air. The average position of the particles does not change during the transfer of the sonic energy. During propagation of the vibrating particles, waves can be reflected, refracted, or attenuated. Ultrasonic sound leak detection is based on sound waves that are above a frequency of 20 kHz. This is at a higher frequency than human hearing can detect. So an electronic device is used to alter the sound waves into a frequency that is in the human hearing range. Ultrasound leak detection works on positive pressure or negative pressure leaks. Ultrasound leak detectors detect turbulent flow produced as the gas moves from the high-pressure side to the low-pressure side of a leak. In order for the leak site to produce ultrasonic sound waves enough gas must be escaping to vibrate the air particles. The sound detector must be in the sound wave emissions area, this is in front of the leak site.

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. 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. 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 interfacial tension) between two liquids. This lower surface tension produces bubbles when the soap is placed at the interface of spaces with varying pressures. 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 be applied to the soap to 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. In a mixture of less than 5.7% hydrogen the hydrogen is non-flammable. This method of leak detection is prone to several problems. With the trace gas being composed of 5% hydrogen and 95% nitrogen, escaping gas is already severely diluted, 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 not hard 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. N2-H2 leak detection was designed to find leaks in underground pipes. Since hydrogen is lighter than air the gas that escapes from the leak rises to the surface were it can been detected.

CO2 Leak Detection

The CO2 system is similar to the hydrogen leak detection system in that it introduces a new gas into the system and a specifically programmed sniffer attempts to identify higher concentrations of that molecule in the ambient air to detect the leak source. 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 so the CO2 will not break down or combine with any other chemical making this a truly system safe. CO_2 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 CO_2 and plug the evaporator condensation drain hose
- 30 - 60 minutes later the plug is removed from the condensation 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 so small it will move through small leak sites with very low resistance. Additionally the pressure when charging the air conditioning can be determined with a pressure regulator. By utilizing CO_2, 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 be forced out of the leak site. With this much higher volume flow rate of undiluted CO_2, any size leak from very small to very large is much easier to detect with the Bullseye dedicated electronic CO_2 sniffer.

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 Bullseye Leak Seeker 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 much of the foam changes color, how fast 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.