

## ***Refrigeration leak detection***

*Refrigeration leak detection has become much more sophisticated since the days of brushing on dish soap and looking for bubbles to appear. More reliable methods to emerge include sophisticated electronic sniffers, newly-developed dyes, and advanced fluids with high sensitivity that have supplanted the traditional soap/water methodology.*

*More importantly, recent developments have produced dependable industrial refrigeration system sealants for leaks that are undetectable or inaccessible for repair. While a relatively recent development, these new sealants stop leaks without affecting system components or performance. Thus, sealants are helping to produce an environment with reduced refrigerant emissions.*

*With a leaking system, many facility engineers are walking a tightrope. On one side of the tightrope are the moral and lawful obligations of eliminating all leaks of refrigerant into the environment. But on the other side, a plant or system shutdown due to leaking refrigeration system repairs can sometimes cost a company millions of dollars in lost productivity.*

*In industrial situations, facility engineers should know leak detection basics, regardless of whether they have a maintenance contract from an outside vendor or they perform service work themselves.*

*Additionally, knowing leak detection basics can sometimes avert a large repair or equipment replacement bill. Dismantling refrigeration systems in a quest for a leak is obviously profitable for the outside maintenance vendor, but it is really the contractor's moral duty to solve the leak problem with the least amount of work and cost possible. Knowing the basics of leak detection can help plant personnel make better judgments on refrigeration system repair work or even perform the repairs themselves.*

### ***Is the system leaking?***

*One key sign in determining a leak is observing a large differential between the evaporator's saturation temperature and the chilled water's discharge temperature. A system might be working fairly well; however any variation from the manufacturer's specifications and current operating condenser, evaporator, chilled water, or oil temperatures, may also suggest a refrigerant leak.*

*These are all telltale signs, but many times technicians disregard these signs of leaking and continue putting new refrigerant into a leaking system. While plant productivity or budget considerations are important, continually filling a system that's leaking is unlawful according to Environmental Protection Agency (EPA) regulations; and harmful to a system over its life cycle. That is why leak detection is just another helpful tool in plant maintenance for the technician.*

### ***It is not the dye, it is the application.***

*A conservative approach is usually best when dyes, leak detection and/or a sealant are involved. This approach should never be used when a piece of equipment is still under the manufacturer's warranty. Secondly, leak detection and repair should be done within the context of local regulations (such as the Montreal Protocol and Environmental Protection Agency (EPA)). Dyes, leak detection and sealants are tools, and all tools can be abused.*

*Dye leak detection involves a dye that is injected into the system. Dyes used for leak detection are generally of two chemical types, perylene and naphthalimide. These two fluorescent dye types have the ability to visibly fluoresce even in small traces and when highly diluted with other fluids. Mixing these with the unit's oil via the refrigerant, transports it to all parts of the system. If there's a leak, the dye will escape with the refrigerant and leave a stain on the external areas near the hole. This is true for even small leaks that might take longer periods to accumulate enough visible residue. Since these dyes are fluorescent, an ultraviolet (UV) light is used to visibly observe the leaking area.*

*In the early days, the rule of thumb was to inject as much dye into the system as possible to easily locate the leak. Since excessive amounts of dye can possibly lead to damage of internal components, these practices unfairly labelled dyes as harmful to refrigeration systems. When used properly, dyes are not harmful to internal components. Annually, tens of thousands of failing refrigeration systems around the world are injected properly with dyes, without adverse effects.*

*There are dozens of dye leak detection manufacturers to choose from today. Generally, many high quality manufacturers use the same type of dye. What separates manufacturers from one another is the injection method and suggested dosages. What a technician should look for is an injector that accurately controls the amount of dye that is injected into the system, and complies with the manufacturer's suggested oil-to-dye ratio for air conditioning and refrigeration systems.*

*Uncontrolled, excessive uses of dye not only lessen the heat transferability of the refrigerant, but also lower the system's oil viscosity. Since excessive dyeing can damage a system, it makes sense to use a small dye dose, combined with a powerful dye detecting UV light to visibly ascertain the leak.*

*Dye applicators that have incremental injections are invaluable for safeguarding against excessive dyeing. Combining with stronger UV lights, which concentrate the light even at great distances or in bright outdoor lighting circumstances, is what elevates fluorescent dye leak detection into an invaluable tool for today's technician.*

### ***Applying dyes***

*Once it is determined the system is leaking refrigerant, and the leak is either undetectable or*

*inaccessible, applying the dye is the first step in repairing a leak. A good rule of thumb is putting .04-ounces (1.25 ml) of dye per 7 pounds (3.125kg) of refrigerant or 20 to 30 ounces (887.2 ml) of crankcase oil. For example with incremental dye injectors, two doses would be sufficient for a system containing 60 ounces of oil.*

*Typically, a return trip is needed after injection because it will take days or maybe even weeks, in the case of slow leaks, for the dye to reach the hole and leak out. A larger leak will be detected in only a few hours after injection.*

*Electronic sniffers should be combined with dye detection because of situations such as intermittent leakage or wind in outside locations. A dye will confirm the leak visually at a specific location. This confirmation is also invaluable, if repair funds must be approved by a company manager for an outside service contractor or equipment purchases.*

*Intermittent leaking generally occurs, when oil or particulate matter plugs a hole temporarily. This is why investigating suspected areas of leakage with a dye as well as electronic sniffing techniques should be used. The dye gives a good historical account of where a leak is intermittently occurring, however, an electronic sniffer can indicate if refrigerant is currently leaking from the hole.*

### ***Seeing the dye***

*UV lights, which are a combination of lamps and projecting lenses that process the light from a flashlight sized container, are used to detect fluorescing dye at a leak's exit point. High powered lights can detect small traces of dye, even in maximum lighting situations such as outdoor sunlight.*

*Generally, dye inspection lamps produce UV, violet, and/or blue light to detect the dye. Violet or near UV lights cause fluorescence of naphthalimide dyes, popularly used in auto and stationary refrigeration systems. Blue light lamps are more universal because they cause fluorescence of naphthalimide and perylene dyes.*

*Inspection lamps range from LED (light emitting diodes), halogen, fluorescent type black light, to HID (high intensity discharge or sometimes referred to metal halide) bulbs. LED lamps are more popular because they require less power to produce a specific narrow range of wavelengths than other methods. LED's, which are cool to the touch, produce a range of wavelengths sufficiently narrow, so that no filter is needed in the lamp to block wavelengths outside the desired range.*

### ***Preparing the system for repair***

*Preparing a system for repair requires refrigerant reclamation and system cleaning in several cases. On large industrial systems, the leak area can be isolated. For example, preparing to fix a leak occurring in the evaporator would follow system pump-down into the condenser.*

*Medium-sized systems such as roof-top package units for office a/c or small systems such as water coolers, window units, etc., would need total refrigerant reclamation and a triple evacuation down to a recommended 350 microns. Micron gauges are useful in this determination because they are more precise than conventional pressure gauges.*

*Using an in-line drier to trap particulate matter or moisture, while reclaiming the refrigerant (if none is available on the reclaiming machine) also guarantees the refrigerant is clean once it is put back into the system, with the exception of a compressor burn out. All driers on the system should be changed as well. Anytime the drier's inlet and outlet psi differential surpasses 2 psi, it should be replaced. Cleanliness within the system is essential, especially if the leak cannot be found or is inaccessible and a sealant is to be used later on.*

*Using dry nitrogen in the system, while brazing the leak area is also essential to keeping oxidised copper particulate matter from sticking to the piping, and later dislodging into thermostatic expansion valves or driers.*

*It is always a good idea to examine the acidity of the system's oil. The sampling tests on the market are those that use two chemical reagents. Reclaimed oil with acidity over .05 on the acid scale needs to be changed. Acid testing can also alert the technician to the presence of excess moisture leaking into the system through the process chilled water side.*

*Considering the value of refrigeration systems especially in industrial applications, it is probably worth the minimal expense to change the oil during pump downs, regardless of the acidic value.*

*Once the system has been cleaned and the leak has been determined as undetectable or inaccessible, a sealant can be used. Using a sealant can save expensive equipment replacement and possible plant shut-downs. For example, at the Ford Motor Company's Windsor, Ontario engine block plant, a chiller used in cooling thousands of litres of honing oil developed an undetectable leak that was suspected to be in the evaporator coil.*

*Instead of shutting down the plant for days to dismantle the machine and with the looming problem that replacement parts might not be readily available, Gerry Miller, the plant's compression equipment engineer, used a sealant. The chiller system is still operating four years later without incident and up to the manufacturer's performance specifications.*

*A sealant is applied via a charging hose connecting the vacuum-packed sealant can to system's low side. Shut down the system and purge air from the charging hose by slightly backing off the can's connection for a minute or less, to allow the system's refrigerant to push air out of the hose. Then, tighten the connection. Open the valve slowly, so that refrigerant enters the can slowly and does not disturb any residual particles in the suction line. The refrigerant will rush into the vacuum-packed can and mix with the sealant. When the can has cooled down to ambient temperature, the technician can proceed to the next step*

*of injecting the sealant into the refrigeration system.*

*Because the sealant application could fill another entire story, instructions and tips have been brief. However, responsible sealant manufacturers do have step-by-step instructions and troubleshooting tips available for users.*

*A sealant works from the inside out. The sealant crystallises from a chemical reaction with atmospheric moisture when it exits a leak point. Therefore, it is critical that moisture is removed from the system, prior to injection to assure there's no damage to internal parts. Once the system is sealed, the sealant stays within the system and continues to do its job in the event another leak might occur months or years later.*

*If a sealed system is reclaimed, the sealant can easily be separated from the refrigerant during the cleaning process. Sealants should be used only as a last resort, when all conventional means of locating and/or repairing a leaking system have been exhausted.*

*Whether a system is repaired conventionally or with a sealant, if performed correctly, the service technicians should have the gratification that their efforts will make a difference in saving the environment from the harmful release of refrigerants, not to mention their company will significantly reduce the repair costs.*