Refrigerant leak detection found attention following the Montreal Protocol in 1987, and while it became illegal to knowingly leak refrigerant into the atmosphere, the issue has continued to be paid lip service by many. Sean McGowan reports on how the introduction of the carbon-equivalent levy on HFCs is changing that.

WHAT'S THE COST OF A LEAK?

On July 1, the Australian Government's price on carbon came into effect, with a carbon-equivalent levy placed on a host of global warming potential (GWP) refrigerants as part of the same legislation package.

In essence, it increased the price of a number of HFC refrigerants overnight and turned many into extremely valuable commodities not to be wasted.

And although much of the industry discussion since has focused on the rights and wrongs of the scheme, much less has been spoken of the importance of containing refrigeration system leaks to not only meet environmental and legal obligations, but save costs.

A major loss of charge now leads to significant financial implications that can be much wider than simply the cost of replacing refrigerant, says Graham Boyle, M.AIRAH, portfolio manager of metals, technology and safety with leading training provider Polytechnic West.

"Refrigerant loss can affect the efficiency of the system, and while some plant can cope with this for a while, generally the operational efficiency is affected leading to longer running times that increase operating costs," Boyle says.

"Service breakdown is also an outcome from refrigerant loss and this may show itself through seemingly unrelated problems such as the evaporator coil icing up or the compressor overheating and perhaps causing a sealed motor burnout. These are symptoms of a greater problem and sometimes the symptom is given attention rather than the underlying problem."

Whether technicians accept the global warming debate or not, allowing refrigerant to leak unmitigated is not only a safety, environmental and legal issue but also a practice more costly than ever before. And it seems the industry is taking note, with a number of leak detection product suppliers reporting increased interest in the technology both immediately before and since the carbon-equivalent levy's introduction.

"The introduction of the carbon tax has certainly focused people's minds on this point," says Bernie Gill, director of sales and marketing for Heldon Products Australia.

"Refrigerant leaks are inevitable but how many businesses can afford to disregard the routine and often unidentified loss of an asset that has dramatically jumped in value by up to 400 per cent?"

LEAK DETECTION – OR LACK THEREOF

Leak detection equipment has historically remained the domain of large supermarket, commercial and industrial installations, where it has formed part of engineered specifications that increasingly take their prompts from energy rating programs like the GBCA's Green Star.

In contrast, the seriousness of leaking systems seems to have been of comparatively little concern for users of small and medium systems. Despite the often large quantities of refrigerant in these systems, leak detection has been considered a nice-to-have rather than a necessity.

Rather, many formed the view that it was cheaper and easier to "top-up" than find leaks and operate tight systems.

"The less concerned refrigeration mechanic would conduct their regular service which included a 'top-up' of refrigerant," says Gary Oborne of GO Distribution, local agents for the Canadian Cliplight range of products.

"They'd say 'She always leaks, mate. It's not worth the cost of mucking around and having you off air while we fix the problem. Just a quick squirt and off we go'."

This practice was outlawed in Australia following the introduction of the Refrigerant Handling Code of Practice in 2007, but it's interesting to note that up to 70 per cent of refrigerant sales in the UK were once reported as being used for this purpose.

It's not inconceivable that this was also the case in Australia. However, just 9 per cent of the national bank is now used for servicing (see HVAC&R Nation Skills Workshop July 2012).

Along with the capital cost of the technology, the ongoing maintenance costs and false alarms regularly associated with this equipment have continued to dissuade many small system users from investing in leak detection.

"Many end users simply see leak detection as a non-returning asset," says Gill.

"The HVAC&R industry has historically been poorly educated in terms of how leak detection should be applied and the type of technology that is suitable. The cost is small in comparison to a major loss of charge in a system and the benefits of leak detection as a way to mitigate refrigerant losses and the dollars associated with this are not really given enough thought by end users.

"We believe it's just a case of educating end users and explaining the significant cost savings from detecting leaking refrigerant early rather than looking at it from a capital expense point of view."

Ordinarily this would be considered a pipedream but it seems such changes in philosophy will be part of a market-based response to the carbon-equivalent levy.

"There is a culture in the industry that minimises preventative maintenance because generally the customer doesn't want to pay," says Boyle. "It will therefore be interesting to see whether this cheapest-price mentality will continue under the carbon pricing environment."

DETECTING THE LEAK

As a global manufacturer and supplier of safety products, MSA Australia's manager of product marketing John Spokes warns against applying this lowest-cost mentality to the choice of equipment, particularly as a flood of cheap, low-quality equipment enters the local market.

He says with so many systems available, and the carbon-equivalent levy being the catalyst for more to be imported, it's important for buyers to recognise those suppliers who specialise in gas detection from those who don't.

"What is critical is the value of the chosen technology to do the job, not the raw cost," says Spokes. "If the system is unreliable, you will be unable to detect an early leak and respond appropriately.

"Detection products and methods differ significantly in reliability, accuracy and detection limits between refrigerants and among refrigerants," he adds.

With so many tools on the market, from integrated, automated systems to hand-held devices, it's important to recognise that there is no one-size-fits-all solution.

"The selection of technology type should reflect the risk and impact of a leak," adds Spokes. "As a general rule, in most applications it is critical you detect as early as possible at lowest concentration without false alarms."

Fixed solutions, typically used on large plant, can include infrared technology or inline pressure monitoring systems and are likely to offer the most reliability, as well as provide remote monitoring.

A recent development in this field is the introduction of fixed, dual-gas systems that enable the monitoring of multiple refrigerant gases in a single system. These are apparently popular with supermarkets operating CO_2 hybrid refrigeration systems that use both CO_2 and a HFC refrigerant like R134a or R404a.

According to Gill, infrared is a proven, reliable sensor technology that is unaffected by cross sensitivity with other ambient gases, and offers stable and accurate measurement of any number of specific target gases with an enhanced product life.

"The chances of false alarms with these systems are extremely low, as the sensors are gas specific, whereas other sensor technologies pick up a variety of gases within a specific spectrum leading to false alarms from things like LPG floor sweepers and CO_2 from fresh meat," he says.

Aspirated systems are also a proven, effective leak detection solution and, while relatively new to Australia, have been used in European supermarkets and large industrial and process HVAC&R plant.

One of their major advantages is the ability to monitor multiple locations on large sites.

Gill says a single system can provide up to 32 individual points of detection for multiple gases, providing effective leak detection coverage of major plant, cold and freezer rooms, service runs and risers and shop floor cases.

BACK TO BASICS

For smaller systems, fixed leak detection technologies are less likely to be adopted and instead any number of other solutions can be employed, including visual checks, soap and bubbles testing, nitrogen pressurisation and pressure hold testing, ultrasonic leak detection, hand held electronic detection and UV dyes.

"A common question asked by technicians is which method of leak detection is the best," Oborne says. "Every type of testing has its good points and it pays to use every tool available to try and track down leaks."

Despite the growing sophistication and accuracy of leak detection equipment, they only indicate the presence of a problem, not the solution.

"In the end a technician has to use a combination of experience and leak detection equipment to pinpoint the leak or leaks, and repair them," says Boyle.

"The most basic technology is sight. In most refrigeration systems oil circulates with the refrigerant which means that when there is a leak there is also oil evident at the site of the leak."

He says the oil attracts dust leaving a tell-tale mark within the vicinity of the leak, making good housekeeping important when servicing plant.

"Any plant should be thoroughly cleaned after a service or during maintenance so that any new oil marks will be evident as a starting point for leak detection."

Another simple method of detecting a leak is the use of soap bubbles. When used following the identification of an oil mark, the bubbles can pinpoint a leak and make for cheap and easy detection.

"In some cases submersion can be used to detect a leak. Of course this is not going to be a first option but sometimes the plant has to be dismantled and individual items pressure tested and immersed in a tank of water to identify the location of a leak," says Boyle.

Despite both methods being reliant on physical access to all parts of the plant, which is not always possible, other more technical methods also have their drawbacks.

For example, nitrogen pressure testing can effectively indicate the presence of a leak but not its location, while ultrasonic systems can be affected by background plant noise. These two are best used in conjunction, as nitrogen will leak at a higher velocity due to its lower specific volume, creating a higher pitched frequency that is easier to hear with ultrasonic detectors.

If used correctly, electronic leak detectors are quite accurate, but again, sensors can easily become contaminated and give false readings.

"Electronic leak detectors measure the electronic resistance of air samples and are highly sensitive, detecting leaks down to 15g per year," says Boyle.

"Their only disadvantage lies in their sensitivity. If the leak is large or the atmosphere is contaminated with even a small concentration of refrigerant, it can be difficult to pinpoint the leak."

The use of UV dye has achieved more recent acceptance in the HVAC&R industry partly due to the fact that it does not require continuous leaking to be able to locate the leak. Oborne says independent laboratory test data has shown that 35 per cent of refrigerant leaks are intermittent.

The dye is added to the system so that, like the oil test, a mark is made where the leak is located. This is then identified with the use of an ultraviolet lamp.

Again like the oil test, this method requires good housekeeping of the plant to keep it clean. Overuse or lack of care when handling the dye can result in dye being everywhere, negating its effectiveness to locate a leak.

Despite an industry-wide preference for the use of electronic leak detectors, halide torches can also be an effective tool in identifying small leaks of fluorinated hydrocarbons.

The torch uses a colourless fuel such as propane-butane which is supplied via a flexible tube and heats a copper ring located near the hottest part of the flame to a glowing red.

When the entry tube is brought close to the source of the refrigerant leak, the refrigerant will burn in the presence of the red hot copper with a green to green-blue colour, depending upon the concentration of the vapour in the air.

For ammonia systems, the pungent smell of the gas is typically the first giveaway of a leak. However, the burning of sulphur is used for small leaks and gives off a white smoke when it comes into contact with ammonia vapours. Similarly, litmus paper changes colour when in contact with ammonia.

LEAK LESSONS

- Know the type of refrigerant in the system prior to commencing leak detection
- Ensure the system has sufficient pressure within it before testing
- Ensure the system is not over pressurised, as this can cause an explosion
- Take care with confined spaces, as asphyxiation can result from refrigerant vapour
- Remember refrigerants can be flammable
- Protect the eyes from UV exposure with protective glasses
- Minimise vibration during installation to avoid pipe fracture and potential for leaks
- Only licensed refrigerant handlers should repair leaks.

PITFALLS AND CONSIDERATIONS

Despite the range of equipment and methods available, leak detection is never easy.

"The larger the system the more time-consuming the task," says Boyle.

"In some supermarkets where there are multiple display cases on a multiplex rack, simply identifying which part of the system has the leak can be a major task requiring the shutting down of sections of the supermarket's refrigeration, so that systematic pressure testing can take place.

"This is never popular with the retailer's management, as they have to empty the affected display cases and find somewhere else for the stock."

Boyle says from a technicians perspective, they are usually always under pressure from the customer to finish the job as quickly as they can, and also pressured by the service controller to get to the next urgent job.

As a consequence, it is inevitable that mistakes are made, so it's important that precautions are taken to ensure the process of leak detection is made both easier and safer for the technician.

The first and most important is to know what refrigerant is contained in the system prior to commencing any leak detection activity, as this will determine what method is best used.

"A gas leak detector (halide) lamp used on a hydrocarbon system may find the leak a little too quickly," says Oborne.

Care should also be taken with UV dyes, as UV rays can damage the eyes. Avoid looking into the UV lamp's beam and always wear UV enhancing protective glasses.

An obvious issue that many overlook is the pressure within the refrigeration system, which Boyle says should be sufficient, otherwise leak detection cannot occur.

"It may seem obvious but it is a waste of time running a leak detector over a system if the pressure in the system is the same as that outside the system," he says.

Conversely, technicians should be careful when pressurising systems that they are not over pressurised, as this can cause an explosion. It's also important to remember that some refrigerants are flammable and present potential combustible risks. Care should be taken when using flames around any refrigeration system.

Boyle says it is also important to consider the environment in which the HVAC&R system is located.

"Check the environment. For example, if equipment is out in the open in a windy environment, this will affect the ability of sensitive leak detecting equipment in finding the leak. If there is any risk of leaking refrigerant being present, take care not to be in a confined space without some assistance as asphyxiation can result from being overcome by refrigerant vapour."

It's for these reasons that leak detection should only be carried out by qualified technicians, and once the leak is identified only a licensed refrigerant handler should repair the leak.

With the value of HFC refrigerants set to increase over the next three years as the country transitions to an emissions trading scheme, the financial implications of refrigerant leak detection have never been greater. ▲

THE DIRTY DOZEN

Prepared by The Expert Group for the Australian Government Department of the Environment, Water, Heritage and the Arts in 2010, a report titled *Refrigerant Emissions in Australia: sources, causes and remedies* found the "dirty dozen" primary sources and causes of refrigerant leaks.

Check them out in the July 2012 issue of HVAC&R Nation at www.airah.org.au