The Advanced Guide to Refrigerant Management

advanced engineering

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Few people remain unaware of the crucial role played by the ozone layer. It helps shield the earth from the most damaging part of the sun's radiation and is an important resource which helps safeguard life on this planet.

To protect the ozone layer the United Kingdom, along with many other nations, has signed international agreements designed to control the production and consumption of certain chlorofluorocarbon (CFC) and halon compounds.

This guide is intended to provide a concise yet accurate and up-to-date overview of responsible refrigerant management with the emphasis on

- Recovery
- Recycling
- Leak detection
- Flushing
- Weighing

If, having read the guide, you wish to obtain further information on any of these topics, please feel free to call our Help Desk on 01256 460303 or fax us your area of interest on 01256 462266.

REFRIGERANT RECOVERY

Why we need to recover refrigerants

Section (33)ic of the Environmental Protection Act which came into force on 1st April 1992, makes it an offence for any person to "treat, keep or dispose of controlled waste in a manner likely to cause pollution of the environment or harm to human health".

The penalties are severe, namely

A. On summary conviction (i.e. in a magistrates court), a term of imprisonment not exceeding 6 months or a fine not exceeding £20,000 or both!

B. On conviction on indictment (i.e. by a jury), a term of imprisonment not exceeding 5 years or a fine (unlimited) or both!

A recovery unit therefore is an essential tool in insuring that not only do you stay within the law but conserve refrigerant, protect the environment and maybe save a £20,000 fine...or worse.

Defining the problems

Before looking at specific models, it is worth considering what is expected from a modern recovery unit, including the ability to:

- move from one recovery application to another
- recover many different refrigerants - often of unknown quality
- deal with systems which may well have acid or moisture within them

With this in mind the first concern must be the type of compressor employed.

Early recovery units were built around hermetic compressors which, though not ideal, were readily available. These proved very popular until refrigerant blends began to appear (there are now over 50 available).

Coping with the hostile chemicals

Along with the new refrigerants came different oils. As a result, today's recovery unit must cope with mineral, polyolester, PAG and alkyl-benzene oils.

Synthetic lubricants (ester and PAG) are both hygroscopic and aggressive solvents. Esters are made from organic acids and alcohol and when exposed to moisture - a common experience for a recovery unit - they can hydrolyse to their acidic components and cause corrosion within the compressor and damage to the windings. As if this is not enough, aggressive solvent action can be a problem in systems, causing corrosion and sludging. Synthetic lubricants can loosen and pick up the products of corrosion which then become suspended in the lubricant. The recovered refrigerant and used oil, can therefore, be contaminated with a variety of particulates and liquids, some caustic in nature.

Moving between applications

Moving from one recovery application to another raises the possibility of cross contamination from refrigerants, acids, and particulates that accumulate in the compressor oil. After all, if those contaminates got into the oil in the first place, they can always get out again...

This may not create a problem where a system is merely being evacuated, but it can cause headaches where the refrigerant is pumped back into the system once repairs are completed.

Similarly it can be a problem when you're switching refrigerants. Mixed refrigerants cannot be reclaimed because they are separable by distillation.

If you are changing from a CFC such as R12, R500, R502 or an HCFC like R22, to an HFC such as HFC-R-134a, not only is the refrigerant different so too is the oil.

Oil-less compressor solves problems

A major breakthrough occurred in 1991 when a revolutionary oil-less compressor was developed specifically for refrigerant recovery, eliminating virtually all of the problems inherent in traditional hermetic technology.

Capable of accomodating every commonly used refrigerant without risk of cross contamination, the oil-less compressor offers numerous advantages. Unaffected by moisture, acid and temperature and with a separate motor, the oil-less compressor can be used without difficulty on mineral, ester, PAG and alkyl-benzene oils.

Light in weight, it does not need the oil separators and acid driers required by traditional compressors.

Making the selection

Engineers and contractors choosing a recovery unit should, therefore, seriously consider first which type of compressor and then the operational features. We have listed features considered essential to a good recovery unit and additional features considered desirable.

ESSENTIAL features when looking for a unit include:

1. Ability to handle a wide range of refrigerants
2. External drive motor
3. Fast recovery
4. Sub cooling feature
5. Self evacuation
6. Push pull facility
7. ARI - TUV certification
8. Deep vacuum facility (29 inches)
9. Unaffected by high or low ambient conditions
10. Technical backup

Each of the above should be convenient and - with the exception of item 10 - should not require complicated hose and bottle changes.

DESIRABLE features should include:

1. Competitive price
2. Lightweight and portable
3. Automatic operation (liquid and vapour)
4. 110 or 240V facility
5. Recharging facility
6. Local demonstration
7. Compressor protection
8. Spare parts available
9. Minimum 12 months warranty on compressor

RECYCLING/RECLAIMING

The difference between recovery, recycling and reclaiming:
Recovery is the process of removing and recapturing refrigerant. No purification of any kind is performed.

Recycling involves the use of machinery that can capture refrigerant and either partially or completely purify that refrigerant through the use of filtration, distillation or both.

Reclaimation is a two step process whereby refrigerant is first recovered and then shipped to an off-site facility to be purified to a known standard. It is then laboratory analysed to verify that this standard has been met.

The need to recycle

Recovered refrigerants should be recycled before they are re-used. Even small amounts of contaminants - acid, moisture etc - can seriously reduce the working life of a system.

A variety of machines are available, some merely circulate refrigerant through filters until the refrigerant is considered ‘clean’.

Choosing a recycler

A better solution is to consider manufacturers who offer single pass recycling with oil separation, distillation and filtration of the refrigerant. It is unnecessary to have all-in-one recovery/recycling units. These are generally bulky, inconvenient to handle, expensive and inflexible.

It is worth noting that when used on recovery and recycling units, hermetic compressors must have their oil changed regularly. The lubricating oil within the crankcase, particularly ester, acts as a sponge absorbing contaminates from recovered refrigerants. When refrigerant is being recycled it goes through a process of cleaning, distillation and oil separation and finally travels through the compressor on its way to the recovery cylinder. If the compressor oil is contaminated, it will in turn contaminate the recycled refrigerant as it travels through the compressor.

Once again, consideration should be given to units employing oil-less compressors. This will ensure that your recycler is compatible with both new and old refrigerants. Low cost recycling modules are available. Rated in accordance with ARI standards, they offer economical on-site recycling.
For reclaimation off-site most manufacturers offer a service which returns the refrigerant to its original condition and, as such, is indistinguishable from pure branded refrigerant.

LEAK DETECTION

A common problem

Most systems leak. Indeed, experts agree that as much as 70% of all refrigerant consumed is for “topping up” refrigeration and air conditioning systems.

In the last few years the state of leak detection has changed dramatically as a result of four factors:

- Concern about our environment
- Legislation to phase out and ban CFC’s
- The escalating cost of refrigerants
- The introduction of time and labour-saving leak detection technology.

What causes leaks?

Refrigerant leaks are a physical path or hole usually of irregular dimensions and most frequently caused by vibration and mechanical stress - flare failures, fractured tubing etc.

The combination of temperature, pressure and vibration often produces intermittent small leaks which will eventually grow to become larger ones. In recent times, incompatible material has also become a major cause of leaks.

Systems using R-134a, given its smaller molecular size, are much more likely to leak. Polyolester oil, used as a lubricant in many R-134a systems, can also act as an aggressive solvent which will seek out and expose any weak points on a system.

Efficient leak detection is, therefore, an ongoing vital factor in reducing costs and system breakdown.

Popular methods of leak detection

Halide Torch - Introduced over 50 years ago it offered everything necessary: a low cost and effective method of detecting leaks. However, as it is unable to work with the new refrigerants and it presents a very real fire and health hazard, the Halide torch is rapidly becoming a museum piece.

Electronic Sniffers - Initially considered to be the replacement for the Halide lamp, electronic sniffers have never gained the same level of dependability. Many are notoriously unreliable and given to frequent false alarms. The sensitivity of an electronic detector is determined by a number of factors, the most important being the type of detector and the material concerned.

For example the ionisation detector that demonstrates high sensitivity for CFC-12 may have worse sensitivity for HCFC-123 and very poor sensitivity for HFC-R-134a. Sensitivity differences of 100X to 1000X have been reported when comparing CFC-12 to HFC-R-134a with some ionisation-based detectors. In this case, the variations in sensitivity would be due to lower concentrations of chlorine, which is very easily ionised and detected, as one moves from the CFC to HCFC to HFC class of compounds.

In an attempt to resolve the problem, some manufacturers now offer an option that allows an operator to choose various sensitivity settings on a single instrument, to suit the application.

Soap Solution - Messy and time consuming albeit effective if you happen to hit the right spot and know where to check. Too slow and inaccurate for serious consideration. Moreover, be aware that some soaps contain chlorides which cause false alarms with halide detectors!

Vacuum Tests - Determines the presence of leaks but not where they are/how many.

Ultrasonic Devices - Cannot be used in noisy areas. They also lack sensitivity, are expensive and are unable to locate either small or multiple leaks, making them impractical for AC&R leak detection.

Helium Leak Detection - Requires the removal of all refrigerants, making it enormously costly and therefore unsuitable for typical service requirements. Developed mainly for use on production lines.

Ultraviolet-Fluorescent Leak Detection - Fast becoming the most popular leak detection technique. Successful UV-fluorescent leak detection systems use a high-intensity ultraviolet lamp and lubricant-specific fluorescent tracer additives infused into the refrigeration or air conditioning system.

In the event of refrigerant loss, a bright fluorescent glow will pinpoint the exact source of every leak.

Proven safe and approved by major compressor, AC&R equipment and refrigerant manufacturers, solvent-free fluorescent additives are available in convenient disposable capsules that are prefilled with premeasured doses of additive.

UV-fluorescent leak detection - dominated by U.S. manufacturer Spectronics Corporation - offers several important advantages over traditional detection methods. It pinpoints leaks as small as 1/8oz per year and remains permanently 'on guard' within the system. Lamps are available in 12V, 110V and 240V versions. Fluorescent additives are available for all common refrigerants including R-134a.

Another advantage is that leak detection is positive, accurate and performed literally at the speed of light. What's more, because minute quantities of fluorescent tracer are deposited at the exact location of the leak, it is possible to find leaks even on those occasions when all of the refrigerant has gone.

The same principle applies with intermittent leaks - the bane of every user and service engineer. These can easily be located whether or not they are leaking at the time of checking.

Finally, UV-fluorescent leak detection is unaffected by draughts, temperature or pressure. As a measure of their popularity, since their introduction into the market in 1989 Spectroline® AR-GLO® UV-fluorescent additives have been installed in over 10 million air conditioning and refrigeration systems world-wide.

FLUSHING SYSTEMS

FOR RETROFIT AND AFTER BURNOUT

The new regulations affecting CFC's have forced R11 to withdraw from the market place as an internal coil system cleaner because of its 'ozone depleting factor'. Until recently no-one has been able to provide a suitable replacement.

Why use a flushing agent?

Compressor manufacturers have determined that more than 95% of compressor burnouts/failures are related to contaminated or dirty systems. Burnouts generate heat which scorch the interior coil lines, causing the oil to form into tar and hard carbon deposits and produce acidic conditions within the coil system. By not removing these contaminants from the system you run the risk of repeated compressor burnouts/failure.

Environmentally-safe cleaner

A new, environmentally safe, bio-degradable interior coil cleaner for refrigeration and air conditioning systems has recently come onto the market designated “CF-20”. It can be used to clean interior coils after compressor failure or burnout and to remove mineral oil residue in preparation for retrofitting. The product can also be used to clean recovery cylinders and all mechanical parts.

Introduced to replace regulated R11 and R12 refrigerants, chlorinated and flammable solvents, it is ozone safe and can therefore be vented to the atmosphere. This new medium will not contaminate oil or refrigerant, is safe and easy to use and has a ‘phased’ evaporation rate.

Use of cleaner before retrofitting

Mineral oil is not compatible with the new HFC refrigerants. Experts therefore recommend that in order to prevent systems from operating inefficiently, mineral oil in the system should be eliminated to 5% or less prior to retrofitting. Currently synthetic oils are being used to flush out the mineral oil. Unfortunately these must be left in the system up to 48 hours and require several flushings, the entire process being very time consuming and expensive.

Using CF-20 eliminates the need to use synthetic oil and, because it is so miscible with mineral oil, CF-20 is much more effective and faster than synthetic oil in breaking down mineral oil and cleaning it from the system. One thorough flushing with CF-20 in the system for up to 1/2 hour will eliminate up to 90-93% of the mineral oil. A second flushing of CF-20 will eliminate 95-99% of the mineral oil. Not only is this new flushing agent more efficient, but it is extremely economical, eliminating the need for multiple flushing over a 48 to 72 hour period.

CF-20 can be used in refrigeration and air conditioning systems that utilise mineral, ester, PAG or alkyl-benzene oils and compatible CFC, HCFC or HFC refrigerants.

WEIGHING

A potential time-bomb

It is imperative that everyone involved with refrigeration and air conditioning be aware of the safety issues involved with recovery cylinders. The primary problem is that cylinders can easily be filled past the “safe fill” level, which is usually considered to be 80 per cent at 70°F/21°C
If a container is overfilled there will be insufficient gas space to allow for liquid expansion if the temperature rises.

Modern, small, lightweight recovery units are very fast - up to 400Kg/hr. In less than 5 minutes a recovery cylinder could be full of liquid. From that point on every 1° rise in temperature will cause a pressure increase of 100lbs... creating a potential time bomb. Particularly when the cylinder is placed in a closed vehicle in warm weather.

The need for purpose-designed equipment

A further problem occurs with used refrigerants since they are often mixed with oil which can effect their density. For example a container filled to 80% level with virgin R12 will weigh about the same as a similar container filled to the 88% level with a mixture of 25% oil and 75% R12.

A dedicated weighing platform, robust and able to weigh to 100Kg or more is therefore essential. This should be able to determine the tare weight, the maximum safe fill weight and, ideally, control the recovery unit, switching it off when the safe set point is reached.

Slim, highly portable scales compatible with most recovery units and programmable to control refrigerant transfer are available complete with dedicated PIN numbers to allow automatic and safe recharging and recovery. Machines with a printer facility are particularly useful and allow refrigerant to be audited, a requirement for companies meeting the REFCOM standard.

We hope that this guide has proved helpful.We accept that it may raise as many questions as it answers including sourcing some of the equipment discussed.We would be pleased to offer additional information and advice. Simply call Barry Wilson on 01256 460300 or fax 01256 462266 for expert assistance.

STOP PRESS

An informative video on leak protection is now available.
Contact us now for more information.

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