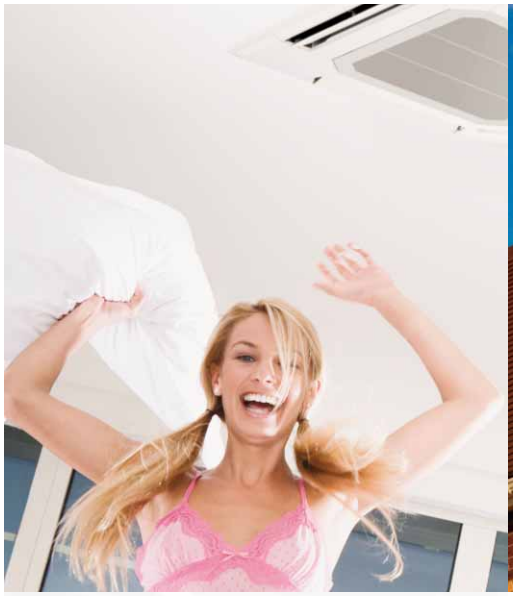
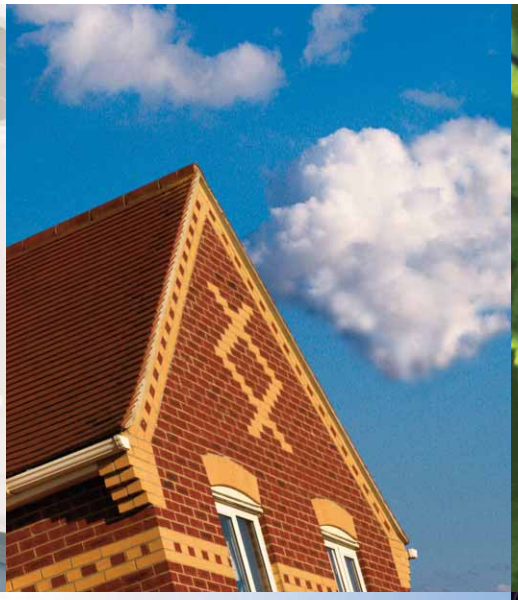


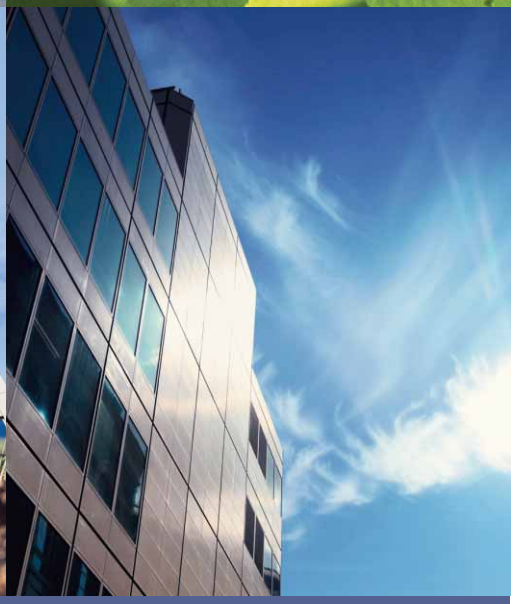

# Information Guide:

# Refrigerants

Issue 27

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MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Information Guide:

# Refrigerants

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today. The guide accompanies a series of seminars, all of which are CPD accredited.

The changing face of construction in the 21st Century demands that designers, specifiers and suppliers work as teams to create better buildings - or occupants and the environment.

Mitsubishi Electric aims to be a part of this by encouraging employees and customers to work together to increase their knowledge of the latest technology, legislation and markets.

## Contents

# The role of refrigerants

The role of refrigerants in air conditioning systems is often underestimated by clients, who are also most likely to be tasked with procurement of air conditioning equipment. As many organisations face increasing pressure to be seen to be running an environmentally friendly business, clients are increasingly asking for air conditioning systems to prove their 'green' credentials. However, it is important that clients are aware of the need to strike a balance between what appear to be environmentally friendly refrigerants and energy efficiency.



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# Refrigerants



The refrigerant plays a vital part in any air conditioning system, since it is the medium by which cooling or heating is carried around a building. During the conditioning process, a refrigerant will change state from a gas to a liquid and back again. The ideal refrigerant therefore has a number of properties:

- A boiling point below the target temperature
- A high vaporisation point
- Moderate density in liquid form
- Relatively high density in gaseous form
- High critical temperature

Operating pressure in a system is also a factor in choice of refrigerants. For example, while high pressures may be suitable for sealed systems such as refrigerators, in air conditioning systems it is preferable that a refrigerant operates efficiently at lower pressure - since high pressure systems would not be desirable in buildings where occupant safety might be compromised.

Many modern refrigerants are blended from a number of chemicals in order to increase the desirable properties of the final product. For example, R407c is a blend of R32, R125 and R134a. The R32 provides heat capacity, R125 decreases flammability and R134a reduces pressure requirements.

Refrigerants have been used for air conditioning for many years. Over that time, their impact on the environment has become better understood and as a result legislation has been introduced banning some types of refrigerant and restricting use of others.

Most recently, the Ozone Depleting Substances Regulations (ODS) and European Fluorinated Gas Regulation (F Gas), have introduced new rules on use and handling of refrigerants. For example, only contractors with a recognised safe handling qualification can handle HCFC and HFC refrigerants such as R22 and R410A. Industry estimates show that there are now around 30,000 people with City & Guilds or CITB Safe Handling of Refrigerants Certificates. The next stages of the ODS will see the eventual phase out of recycled R22 and an eventual ban on the use of R22 refrigerant. (See the Mitsubishi Electric Guide to R22 for more details).

However, for many large organisations and well known high street brands, lobbying by green groups is creating more pressure than legislation could to examine their refrigerant use.

Recently, there has been a call by environmentalists that large supermarkets should only use refrigerants with very low or zero Global Warming Potential (GWP). This figure represents the 100-year warming potential of 1kg of gas, relative to the impact of 1kg of $CO_2$. Carbon dioxide is allocated a GWP of 1.

The GWP measure is already being used by the European Union to cut back on certain refrigerants. For example, from 2011 the EU will phase out automotive air conditioning refrigerants with a GWP of more than 150.

But as we shall see in our next section, GWP is not as clear-cut an indication of environmental credentials as it may appear - other factors need to be considered when looking for efficient solutions to a building's heating and cooling requirements.

# Efficiency and environment
## - striking the right balance

While Global Warming Potential (GWP) provides a standard single number for assessing a refrigerant's impact on the environment, it does not tell the whole story. Unfortunately, GWP is currently being used by environmental lobbying groups, Government and opposition parties to justify moves to ban HFC refrigerants completely.




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# Refrigerants



The important word to note in GWP is 'potential'. The GWP figure only measures the direct impact of a refrigerant on the environment. That is, the impact only happens if that refrigerant leaks into the atmosphere. What GWP does not take into account is the indirect impact on the environment - that is, the energy used by a refrigeration or air conditioning system. This impact is most usefully measured by the Coefficient of Performance (COP).

The ratio of indirect/direct impact of refrigerants is generally understood to be in the region of 15% indirect to 85% direct impact on the environment. While leakage is an important issue for installers and users of air conditioning systems, it has less of an impact on the environment than the energy used by an air conditioning system.

Unfortunately, it is currently difficult to specify a refrigerant which has both a low GWP and a high COP whilst still satisfying safety and materials compatibility criteria. For example, $CO_2$ can be used as a refrigerant and has a low GWP of just 1. However, for most applications it will have a lower COP. On the other hand, R410A has a GWP of around 1825, but its higher COP will result in less global warming because of the reduced energy consumption during its working life.

Perhaps a more balanced method to assess the environmental impact of a refrigerant is to use TEWI - Total Environmental Warming Impact. This calculation takes account of direct and indirect effect and includes consideration of likely leakage rates, equipment life, rate of refrigerant recovery at end of equipment life, $CO_2$ output of power generation etc. (The calculation and a spreadsheet can be downloaded from the Institute of Refrigeration website.)

However, it is fair to say that leakage has been a problem for the air conditioning industry in the past. Over the last few years however, the leading manufacturers and installers have made great efforts to vastly reduce leakage. Rules introduced through the F Gas Regulation also mean that there are closer checks on handling and use of refrigerants.

At the heart of the Regulation is the principle that leakage of the refrigerants is what causes damage to the environment, both directly and indirectly, and that the refrigeration and air conditioning sectors must raise standards in maintenance and training.

There is an urgent requirement for the industry to reduce leakage rates, because of the growing possibility that the next iteration of F Gas Regulation could also see a ban on R407c and R410A. These are highly energy efficient refrigerants for many modern air conditioning applications, so the industry would be hard placed to find reasonable alternatives. A review of the F Gas Regulation is due soon, and a new version will be published in 2011.

The efficiency of air conditioning systems is also under scrutiny because of other legislation including the European Energy Performance of Buildings Directive and the Carbon Reduction Commitment. It is vital that clients understand the need to take a holistic view of their air conditioning - not simply the refrigerant that it uses, but how it is used and maintained. Long term efficiency is by far the best approach for clients and the environment.

# The future of refrigerants
## - and air conditioning

With growing interest in reducing the environmental impact of air conditioning systems, investigation into alternatives to HCFCs and HFCs is already underway. The main challenge is to find alternatives which are energy efficient, safe and practicable for use in air conditioning systems. Capital cost is also an important factor. Clearly, finding all of these characteristics is something of a challenge and to date there are only a small number of systems currently using these alternatives.





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# Refrigerants



## Ammonia (NH3)

NH3 is a commonly cited alternative refrigerant and it does have some useful properties including high efficiency. It has no ozone-depleting potential or global warming potential. At first glance it seems to offer the ideal solution. However, ammonia is a toxic substance, although its strong smell usually gives ample warning of any leakage. The substance can also be flammable.

While ammonia has been used successfully in large systems, its application is difficult for medium and small systems. One of the main reasons that ammonia-based systems have not been widely used in building air conditioning is its corrosive action on copper piping. All pipes have to be made in steel, which adds greatly to the cost and weight of the resulting system.

## Hydrocarbons

Pure hydrocarbons such as propane and butane have been suggested as alternatives. However, they are highly flammable. There are many safety regulations regarding their use, which prohibit its wide application.

## $CO_2$

$CO_2$ does offer a number of environmental advantages such as zero ozone-depletion potential. It is also non-toxic and non-flammable. Carbon dioxide requires high operating pressures, as well as thicker and heavier pipework. While it is practical for chiller cabinets in the retail sector (where systems are sealed and at floor-level), the high pressure systems are currently less applicable for air conditioning. It also has a low critical temperature which make $CO_2$ less energy efficient than today's refrigerants.

## Changing system design

While alternative refrigerants may not offer a direct application in today's air conditioning systems, it is possible to foresee a time when systems are redesigned to accommodate their characteristics. For example, it has been suggested that while a refrigerant such as ammonia can be used, it would be better to keep the refrigerant away from occupants, and use a secondary refrigerant to transfer the heat around the building.

Effectively, the ammonia (or carbon dioxide) is confined to a sealed vessel, cooling a non-volatile secondary refrigerant such as glycol. This uses the refrigerant characteristics of the alternatives, whilst addressing the health and safety issues. This method has been applied in cold stores and for supermarket refrigeration, but has yet to be applied to air conditioning.

End-users are having to pay careful attention to their refrigerant use, as two very important deadlines are approaching. The first is December 31st 2009, when the use and sale of all 'virgin' HCFCs such as R22 will be banned. It is important to note that this includes any refrigerant purchased before the deadline, use of which is also prohibited.

The second deadline is still a few years away, but one which will certainly affect purchasing and maintenance decisions much sooner. On December 31st 2014, the use and sale of recycled HCFCs will also be banned. The use of non-refillable containers for transporting or storing HCFCs is already banned.

Although the replacement of R22 and dealing with the F Gas rules could be viewed as an inconvenience, they also offer an opportunity for air conditioning installers and contractors to give good advice on the choice of alternative refrigerants - balancing the need for 'green' refrigerants with the requirement for long-term building energy efficiency.

# Further information

You can find more information on the topic of **Refrigerants** and related issues at the following websites:

**www.mitsubishielectric.co.uk/aircon**
for information on energy efficient refrigerant choices and the new rules on use of R22

**www.fgas.org**
for information on F Gas regulation and R22 phase-out

**www.berr.co.uk**
Department for Business, Innovation and Skills.
See the section on Sustainability for information regarding F Gases and Ozone Depleting Substances.

If you missed the CPD seminar on **Refrigerants** you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

**Please call one of the numbers below:**

| | |
|---|---|
| London North East & East Anglia | **01707 282480** |
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## Regional Sales Offices

**Birmingham**
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Fax: 0121 7412801

**Bristol**
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Fax: 01707 282481

**London Central Region**
Tel: 0207 9286810
Fax: 0207 9286569

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Telephone: **01707 282880**
email: air.conditioning@meuk.mee.com web: www.mitsubishielectric.co.uk/aircon

UNITED KINGDOM Mitsubishi Electric Europe Air Conditioning Systems Division
Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, England.
General enquiries Telephone: 01707 282880 Fax: 01707 278674

IRELAND Mitsubishi Electric Europe Westgate Business Park, Ballymount, Dublin 24, Ireland.
Telephone: Dublin (01) 419 8800 Fax: Dublin (01) 419 8890 International code: (003531)





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www.greengatewayinitiative.co.uk