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Mitsubishi Electric Guide to Chiller Technologies

Information Guide 58

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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.

This guide accompanies a series of seminars, all of which are CPD certified.

Contents

The drive to save energy in buildings

The key challenges for commercial buildings over the next 20 years are energy efficiency and carbon reduction. The Committee on Climate Change is focused on a 50% reduction in carbon emissions from 1990 levels by 2025.

Largely, this goal is the common denominator behind all current legislation and initiatives set up by the Government. Even though the UK Government in July 2015 abolished plans for all non-domestic buildings to be zero carbon by 2019, the current legislation still stands - and more will be imposed via the European Union.

As a result building designers, managers and owners must still comply with Part L of the Building Regulations, which concerns itself with the conservation of fuel and power. This legislation was updated in April 2014 to reflect the increasing focus on carbon reduction, with a new target of 9% improvement on the levels set under Part L 2010.

This update to Part L included the introduction of minimum energy efficiency targets for air conditioning and lighting replacements.

As well as the revision of Part L, there has been a raft of regulations such as Energy Performance Certificates (EPCs) and the new Energy Saving Opportunities Scheme (ESOS) that were designed to drive greater energy efficiencies in buildings and across businesses as a whole.*

*Please see additional Mitsubishi Electric Information Guides for further information on these topics.

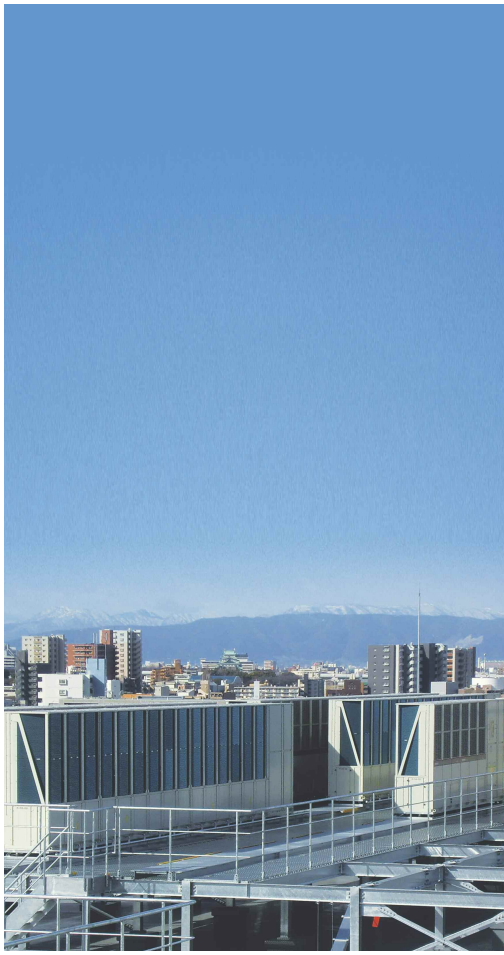
The other major driver in the bid to save energy in our buildings is, of course, the rise in energy prices.

According to the Competition and Markets Authority, gas and electricity prices have risen by 125% and 75% respectively in the past ten years. The Energy Managers' Association is predicting that this upward trend will continue, and we may even see some businesses pushed into 'fuel poverty' before too long.

These conditions have all converged to drive product innovation by manufacturers to ensure their ranges meet energy performance requirements required by law.

It is widely accepted that building services use the bulk of energy in most non-domestic buildings - around 80% according to bodies such as the Carbon Trust.

Equipment for air conditioning, ventilation, heating and lighting has been under the microscope by designers to find ways to save as much energy as possible.



Chillers and their functions

Water cooled chillers and air cooled chillers are refrigeration systems used to cool fluids in both commercial buildings and industrial facilities.

Chilled water has a variety of applications from space cooling to process uses. The components of water cooled chillers and air cooled chillers are very similar. Each product contains an evaporator, condenser, compressor, and an expansion valve.

The primary difference is whether air or water is used to provide the condenser cooling.

How chillers work

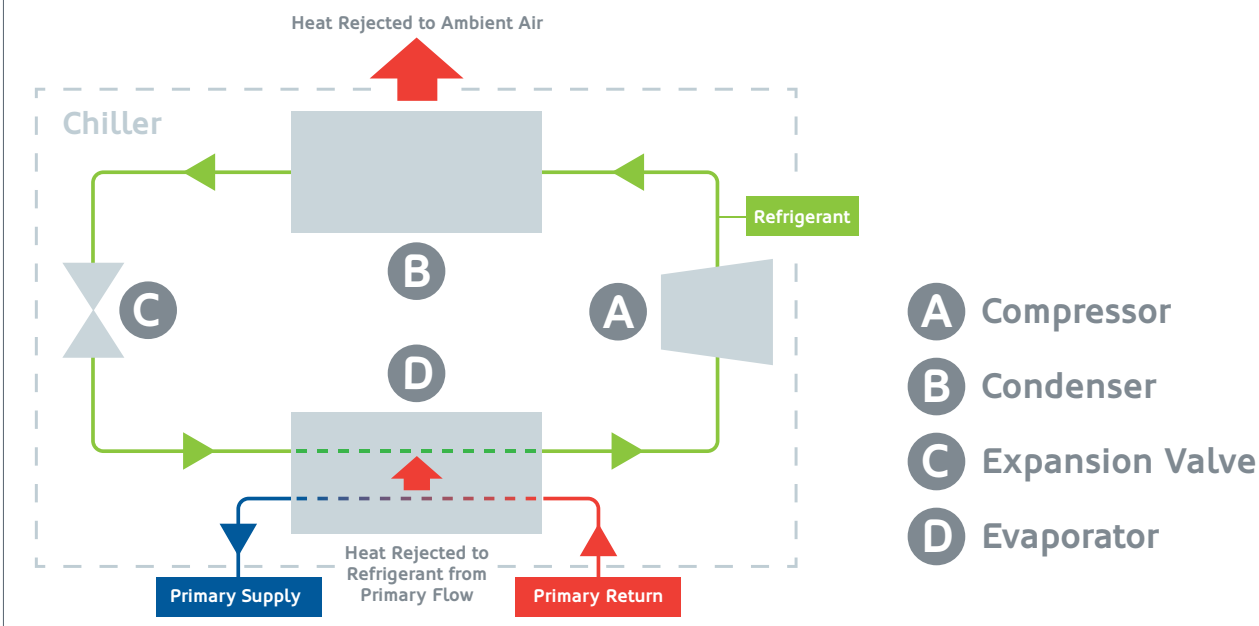
A chiller removes heat from a liquid via a **vapour compression cycle**. This cooled liquid can then be circulated through a heat exchanger to cool air.

The vapour compression cycle begins in the **compressor** (A) where liquid refrigerant (for example, R410A) gains pressure and temperature. At this stage, the refrigerant is a hot vapour, which moves into a **condenser** (B) where it is cooled and turned into a liquid. It is at this point that the refrigerant is rejecting heat from the system, thereby removing it from the building.

After the condenser stage, the refrigerant moves into the **expansion valve** (C) where pressure and temperature are reduced. This cooled refrigerant then moves into the **evaporator** (D), where it passes through tubes or coils which cool air that is then transferred to the occupied space - providing cooling for the building.

The refrigerant then passes back into the compressor to begin the cycle again. Refrigerants in the vapour compression cycle can transfer their heating or cooling energy to water or air, depending on the type of cooling system installed.

The vapour compression cycle within an air cooled chiller



New chiller technologies for greater efficiency

Air conditioning is acknowledged as a significant energy user in buildings. The latest chiller technologies help to address this by ensuring that they operate to meet the precise cooling demand of the building.

Inverter technology is key to this aspect of energy efficiency. For example, the recently launched Mitsubishi Electric *e*-series modular chiller uses two advanced DC inverter driven scroll compressors. This delivers a capacity range of 8% to 100%, ensuring that the chillers do not operate at full capacity when that is not required.

Not only does this reduce the energy costs of the chillers, it can also ensure longer operational lifetimes. Compared to a fixed speed or mechanically modulated compressor, an inverter compressor can reduce annual energy bills by up to 30%.

Manufacturers have driven down the energy usage levels of their products, and work hard to identify even small adjustments that can impact on efficiency.

For example, one of the innovations in chiller technology is the use of U-shaped heat exchangers. These offer a greater surface area than the conventionally-shaped heat exchangers.

An additional benefit is that the chillers are much narrower than conventional products - saving valuable floor space.

Another innovative approach is to use a two-stage cooling circuit. Two compressors are used in a single chiller unit, with each compressor serving a separate plate heat exchanger.

By modulating the evaporating temperature individually, overall system efficiency can increase by an additional 3.9%, compared to single evaporation refrigeration cycles. By having two separate refrigerant circuits, it also allows the system to carry on operating in the unlikely event of a component failure within one of the circuits.

Why now is the time to think about your approach to cooling

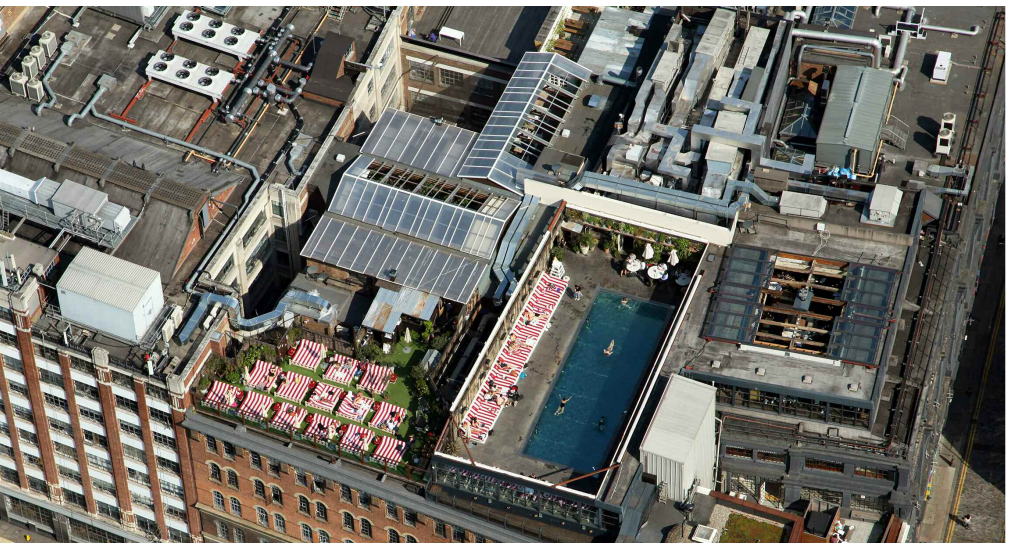
The F-Gas regulations are forcing many businesses to spend time assessing their cooling systems. As of January 2015, systems using the banned R22 refrigerant can no longer be repaired or topped up with that refrigerant.

The options are to wait until such systems fail before upgrading; top up with 'legal' refrigerants; or undertake a full replacement before issues begin to arise.

There are a number of issues to consider when deciding on a course of action. These include:

- *The age of the existing air conditioning system;*
- *The efficiency of that system, both in terms of ongoing maintenance costs and operational energy costs;*
- *Leakage problems;*
- *Whether alternative refrigerants are compatible;*
- *Efficiency and availability of modern refrigerants and equipment manufacturers' advice about using modern refrigerants.*

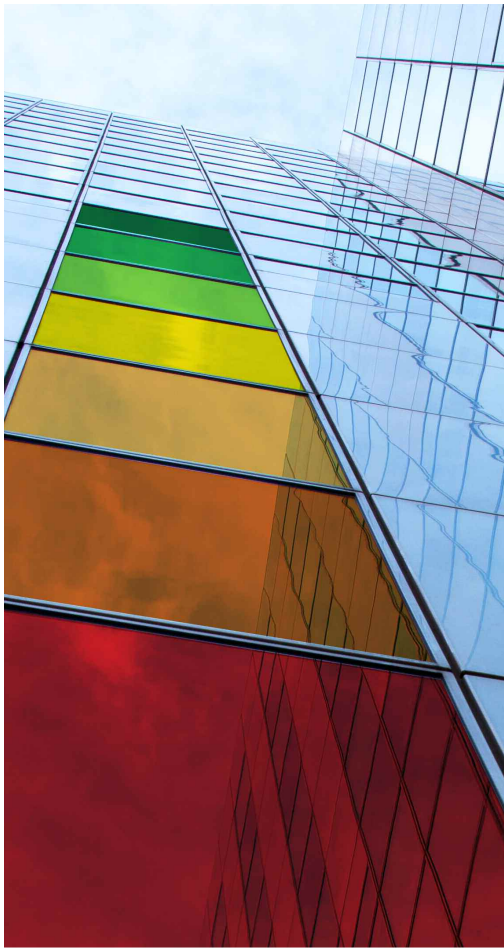
It is possible that using modern refrigerant in converted systems can lead to poorer equipment performance and, ultimately, higher energy costs. Any increase in energy costs is something property owners and occupiers will want to avoid. For many buildings now is a very good time to replace older air conditioning systems which will not only comply with F-Gas regulations, but also offer lower operation and maintenance costs - and probably a better indoor environment for occupants too.



The importance of the EPC rating

It is also important for building owners to remember that as of April 2018, it will be illegal to let out commercial buildings with an EPC (Energy Performance Certificate) rating lower than E.

Landlords looking to make a move up the EPC ladder should view the replacement of chillers and boilers as a good route to a higher rating.



Why refurbishment / replacement is probably easier than you think

Chillers are not commonly high up the list for replacement by building owners due to perceived costs. But a study of the lifecycle costs of installing a new, far more energy efficient chiller, should provide a convincing argument.

Existing chillers can often be dismantled and taken out through existing access points to ease disruption, and in many projects existing runs of pipework can also be used, reducing replacement costs considerably.

Advances in technology and the legislative drive towards greater energy efficiencies are going to make many landlords and occupants think carefully about the replacement of cooling systems in their buildings.

A keen understanding of the benefits of the latest equipment and how it can enhance a building's energy performance will prove to be a vital tool for installers.

Case Study - Mitsubishi Electric Nagoya Works

When Mitsubishi Electric was looking to build a new production facility for its range of factory automation products at the company's Nagoya Works, located in Aichi Prefecture, Japan, the need for energy efficiency was paramount to match the company's ambitious carbon reduction targets.

The production facility plays a key role in meeting the growing global demand for reliable, high-quality factory automation products and like all modern buildings, it is constructed to the highest standards of air tightness and insulation.

The 26,000 square metres of floor space throughout the six storey building needs to be comfortable for staff and visitors alike, as well as incorporating the most advanced energy-efficient measures possible.

In addition to a 50kW photovoltaic system on the roof, low voltage LED lighting and comprehensive energy management systems, the factory is also benefiting from the installation of 48 of the company's *e*-series modular chiller range - which brings a modern, low carbon update to traditional standard chiller technology.

The controls for the high-efficiency chiller units at Nagoya Works have been easily integrated into the Building Energy Management Systems (BEMS) system so that they can operate smoothly alongside the Air Handling Units and VRF air conditioning, to maximise efficiency.

In addition to delivering 4.3MW of cooling and heating to the building, the modular approach of the *e*-series chiller range reduced both space and weight on the rooftop and the in-built header pipes simplified the design and installation. The ability to position units as close as 900mm apart has also ensured easy access for maintenance.

e-series

To receive a CPD seminar on the 'Chiller Technologies', you can call your Mitsubishi Electric Regional Sales Office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

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