The Renewable Solutions Provider
Making a World of Difference

Mitsubishi Electric Guide to Ventilation

Information Guide 46

MITSUBISHI ELECTRIC
LIVING ENVIRONMENTAL SYSTEMS

Air Conditioning | Heating
Ventilation | Controls

CPD CERTIFIED
Construction CPD Certification Service
Collective Mark

Mitsubishi Electric Guide to Ventilation

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 accredited.

Contents

Air quality, comfort and ventilation

Occupant health is a very important issue for building designers and managers. If the occupants of a building do not feel healthy and happy within that environment then they cannot be productive. This is true whether the building is a primary school or an office.

There are a number of factors that affect how humans react to their indoor environment, including access to daylight, type of lighting, temperature and space. One of the elements that has the most direct impact on health is ventilation. Indoor air quality (IAQ) has been the subject of a number of studies over the past decades, and it is widely agreed that good IAQ is an issue that needs to be considered and dealt with as a priority.

The Chartered Institute of Building Services Engineers (CIBSE) defines good indoor air quality as air with no known contaminants at harmful concentrations[1]. It may seem obvious that office workers should have pollutant-free air to breathe, however, there are a number of such contaminants that are often found in that environment including volatile organic compounds (VOCs) that are released from carpet glues; carbon dioxide from occupants; odours and other particulates.

CIBSE defines the requirements for good IAQ as:

- Provision of sufficient fresh air supply rates to dilute and remove pollutants
- Effective ventilation
- Low external pollution concentrations
- Low internal pollutant rates from materials such as carpets and other sources like photocopiers

The table below shows the sort of rates of ventilation required to achieve these aims[2]. It should be noted that the figures are not cumulative, therefore the 10 litre/s per person will not only provide a feeling of freshness, but also dilute occupation contaminants, dilute carbon dioxide and provide required oxygen.

Provide oxygen	0.2 litre/s per person
Dilute carbon dioxide	1.0 litre/s per person
Dilute occupation contaminants	5 litre/s per person
Give a feeling of freshness	10 litre/s per person

(Note: Figures are not cumulative)

Sick building syndrome (SBS) is one possible result of poor health caused by buildings. It is not entirely due to ventilation (lighting and high ambient noise are among other causes) but lack of fresh air is one of its major causes. Symptoms include skin irritation, headaches and lung irritation.

Overall, a ventilation system sends fresh air where it is required minimising pollutants and optimising occupant health. Ventilation can therefore have a number of roles in supporting occupant health and comfort in a variety of buildings and areas within a building, **such as:**

- Providing fresh air that is required by occupants for good health
- Dilution and removal of pollutants
- Extract from kitchens and toilets
- Distributing conditioned air (for heating and cooling)

Part F of the Building Regulations (2010) deals with ventilation in buildings. For non-domestic buildings the required rate of ventilation is 10 litres/s per person. It is interesting to note that changes to occupation levels in a space should therefore be accompanied by changes to the ventilation rate to ensure good IAQ.

Other guidance suggests that for a high standard of indoor air quality, a ventilation rate of 15 litres/s per person is more appropriate (BS EN 13779 Ventilation for buildings). This standard describes 10 litres/s per person as a moderate to medium IAQ level. Ventilation can also impact on the temperature of the internal space. For example, higher ventilation rates may increase indoor air quality but could cause drafts, causing occupants to become uncomfortable. Designers therefore need to be aware of this aspect of comfort when calculating ventilation rates.

Designers have a number of options for selecting an approach to ventilating a building. Natural ventilation is one approach, where the building relies on natural air movement across the space to draw in fresh air and to expel stale air. Some buildings utilise a mixed-mode approach where natural ventilation is supported by a mechanical element to achieve more stable comfort conditions. However, natural ventilation may not be an option in highly polluted urban environments; or in deep buildings where floor sizes are large. For many buildings, therefore, mechanical ventilation is required to achieve good occupant health and comfort.

Our next section examines an important element of the mechanical approach - the air handling unit (AHU).

References: 1. Indoor air quality and ventilation, CIBSE Knowledge Series (KS17)
2. Comfort, CIBSE Knowledge Series (KS06)

Air Handling Units - supporting energy efficient ventilation

There are three main approaches to mechanical ventilation in buildings:

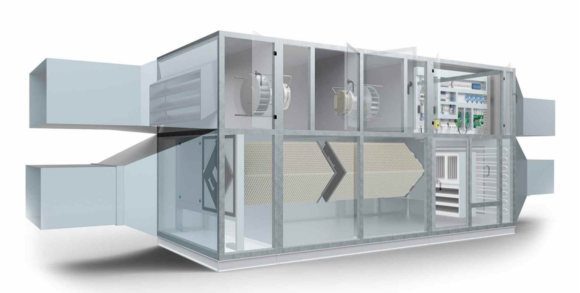
1. Supply only ventilation
2. Extract only ventilation
3. Balanced ventilation

Supply only ventilation creates a positive pressure within a building, which means that if the fabric of the building is leaky, air is less likely to infiltrate. Extract only systems remove air from a space mechanically causing negative pressure thereby drawing fresh air into the building through passive openings. Moisture can be extracted from the incoming air to reduce moisture within the building by using dehumidifiers.

A Balanced ventilation system supplies and extracts air simultaneously and can combine the benefits of both systems.

An air handler, or air handling unit (AHU), is a key part of a mechanical ventilation system. An AHU can consist of a number of key components including:

- A fan deck
- Heating and cooling elements
- Filter racks
- Sound attenuators
- Dampers



Air handlers connect to a ductwork ventilation system that distributes air through the building and returns it to the AHU. In some cases the AHU supply (discharge) air and return air directly to and from the space served without ductwork. In other cases a large outdoor AHU supplies air to local, smaller handlers known as fan coil units (FCUs). Whatever their size, air handling units are essentially used to treat the fresh air ventilation load in buildings.

The AHU works using internal coils that use water, steam or refrigerant for heating and chilled water or refrigerant for cooling. The coils are usually made from copper with aluminium fins to maximise heat transfer. Hot water or steam (for heating) is provided by a central boiler; cold water for cooling is provided by a chiller. In some cases, the AHU can be fitted with a frost coil to raise the temperature of very cold incoming air and hence protect the other coils. In extreme conditions, sensors will shut down the AHU if external temperatures drop too far.

For dehumidification, the AHU creates forced condensation from incoming air by cooling it to dew point. The air, with reduced water content, is then reheated before entering the occupied space. The latest AHU technology uses heat pumps for both heating and cooling. This option is considered highly energy efficient.

As with much of today's building services technology, the energy efficient performance of AHUs is of great concern. The latest air handling units utilise a number of low-energy techniques that are reducing the overall energy required to heat and cool a building.

For example, the application of inverter-driven heat pumps used with air handling units is reducing energy use and moving away from carbon-based fuels such as gas for heating.

It is also possible to make further energy savings by using free cooling. A damper is incorporated into the AHU which can be adjusted to allow full or partial free cooling using outside air.

Heat recovery is another technique that can help to lift energy efficiency, and is discussed in more detail in the next section of this guide.

Further reading: CIBSE Guide A - Environmental design
CIBSE Guide B - Heating, ventilation, air conditioning and refrigeration

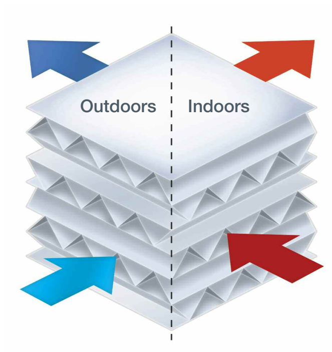
Mechanical Ventilation with Heat Recovery (MVHR)

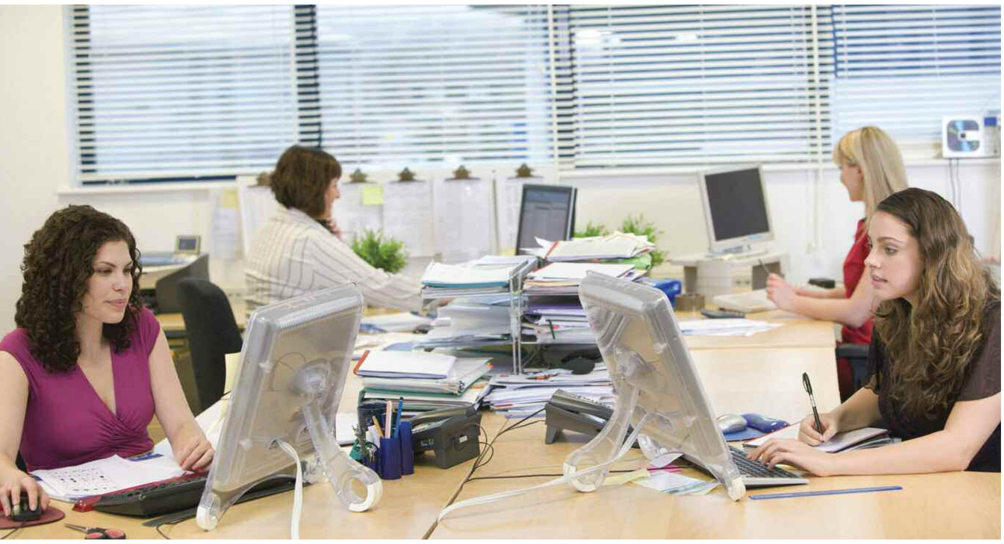
Ensuring that the correct quality and temperature air are supplied into a building is very important, not only for occupants but also for the building itself. The UK's climate for most of the year is around 8ºC to 20ºC, which can often allow for the use of free cooling which is effective and energy efficient.

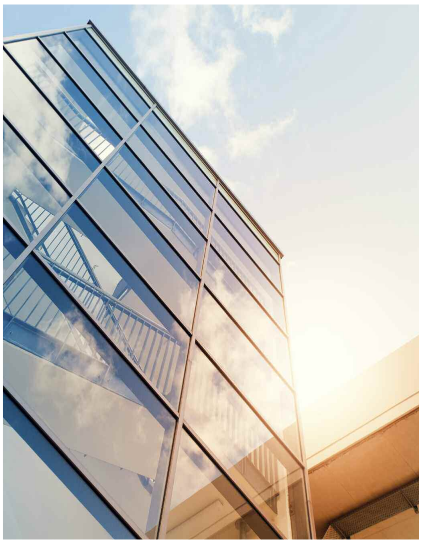
However, many commercial buildings are of a size or design that require mechanical ventilation. In these cases, the addition of heat recovery technology can help to save energy by reducing the heating and cooling requirements. For example, the application of heat recovery can reduce overall cooling loads by up to 20%.

The diagram opposite shows how heat recovery reduces the amount of heating or cooling required to bring the incoming supply air to a usable temperature.

For example, in winter, as warm air is extracted from the building it can be used to raise the temperature of incoming cold air. In summer, cooler air leaving the building can also be applied to lower the temperature of the warm supply air.







The Non-domestic Building Services Compliance Guide 2010 recommends the application of heat recovery for air supply and extract systems that include heating or cooling.

The Guide recommends minimum dry heat recovery efficiency levels for heat exchangers for new and existing buildings, as shown in the table below.

Heat exchanger type	Dry heat recovery efficiency
Plate heat exchanger	50%
Heat pipes	60%
Thermal wheel	65%
Run around coil	45%

Long-term efficient and effective mechanical ventilation is considered in our next section, with particular emphasis on design, controls and maintenance of the system.

Sensible and latent heat - why they matter

When an object or substance is heated or cooled, heat is added or removed. This heat is known as sensible heat.

When enough heat is added or removed, substances can change state: water to steam; water to ice. In this case the temperature of that substance will not change - water that is boiling at 100ºC will turn into vapour with the addition of more heat, but its temperature will not rise. The heat that is removed or added to change the state of a substance is called latent heat, because it does not alter the temperature of that substance.

In air conditioning systems, total capacity is sensible + latent heat. Total capacity measures the system's ability to both dehumidify and cool air. During cooling, latent heat is removed from the air which condenses (i.e. changes state) into water - so that the air is dehumidified. In order to reduce the temperature of the air, the system must also be able to remove sensible heat - so that the air is cooled as well.

Systems which can achieve both sensible and latent heat transfer have a higher heat recovery and efficiency. This is because water has a higher specific heat capacity than air, meaning that it can transfer, or recover, more heat energy than air.

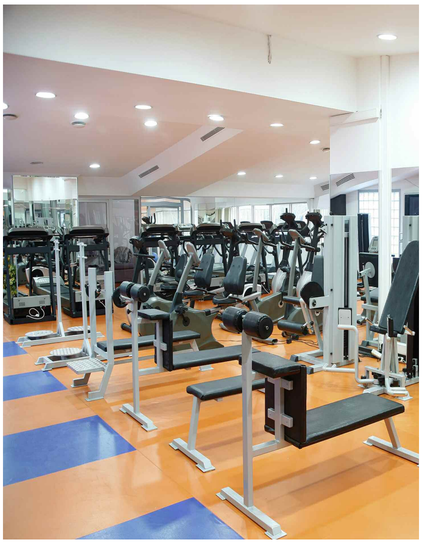
Energy efficient ventilation - design, control, commission and maintain

Mechanical ventilation has the potential to be a high energy-using area of building service. However, with considered design, proper commissioning, good control and continuous maintenance, the operation of mechanical ventilation systems can be both effective and efficient.

When considering the design of a mechanical ventilation system, consideration needs to be given to key equipment such as the air handling unit .

Specific fan power (SFP) is an overall measure of the energy efficiency of a ventilation system[1]. SFP measures the amount of energy required to move an amount of air through the system. It takes into account pressure drop and fan power. The amount of power used by fans in ventilation systems is covered by Building Regulations[2]. The table below gives an indication of these requirements, which are recommended minimum standards.

Ventilation system	SFP (W/(l/s)) New building	SFP (W/(l/s)) Existing building
Central mechanical ventilation system including heating and cooling	1.8	2.2
Central (balanced) mechanical ventilation including heating only	1.6	1.6
All other central (balanced) mechanical ventilation systems	1.4	1.8
Zonal supply and extract ventilation units such as ceiling void or roof units serving a single room or zone with heating and heat recovery	2.0	2.0



Performance of the ventilation system at different flow rates is covered in the same Regulation which states that 'air handling systems should be capable of achieving a specific fan power at 25% of design flow rate no greater than that achieved at 100% design flow rate'. Variable speed drive fans are recommended.

Also, when considering the long-term energy efficiency of a ventilation system designers need to be aware that ductwork has a significant impact on performance. If ductwork unnecessarily adds to the resistance that the fans in the AHU have to overcome, that will increase the specific fan power of the system. Well-constructed and installed ductwork is recommended, with a view to reducing leakage and air resistance.

The Building Regulations also include recommendations for types of control for use with ventilation systems. These include time controls; defrost controls and overheating controls (depending on the functionality of the system). Demand control ventilation is considered highly effective at ensuring that ventilation is only delivered when it is required.

The commissioning of air distribution systems is an important step in ensuring that the system is set up from the start to operate effectively. Detailed guidance is given in CIBSE Code A[3]. This document takes a detailed step-by-step approach to checking all aspects of the ventilation system from components of the AHU, through to ductwork, flow rates and electrics.

One of the key functions of ventilation is to provide a healthy working environment. Good maintenance of the system should therefore not only be about system performance, but system hygiene. CIBSE TM26[4] has clear recommendations for dealing with ventilation ductwork. Legislation covering this area includes the Health & Safety at Work Act (1974).

Carbon Trust guidance recommends regular checking of filters to remove blockages - cleaning fans, filters and air ducts can improve efficiency by 60%[5]. With careful attention to selection, installation and operation a mechanical ventilation system will give efficient and effective service for many years.

References:
1. CIBSE Technical Manual 30: Life cycle performance of mechanical ventilation systems.
2. Non-Domestic Building Services Compliance Guide, 2010 DCLG (Section 10 table 36)
3. CIBSE Commissioning Code A: Air distribution systems (1996; confirmed 2006)
4. CIBSE TM26 Hygienic maintenance of office ventilation ductwork (co-authored with BSRIA)
5. Carbon Trust, Heating, ventilation and air conditioning: saving energy without compromising comfort www.carbontrust.com

To receive a CPD seminar on Ventilation 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 **ventilation@meuk.mee.com**

Further information

Regional Sales Offices, Please call one of the numbers below:

Birmingham
Tel: 0121 741 2800 Fax: 0121 741 2801

Bristol
Tel: 01454 202050 Fax: 01454 202900

Wakefield
Tel: 01924 207680 Fax: 01924 207699

Scotland
Tel: 01506 444960 Fax: 01506 444961

Manchester
Tel: 0161 866 6060 Fax: 0161 866 6081

London South Region
Tel: 01737 387170 Fax: 01737 387189

London North Region and East Anglia
Tel: 01707 282480 Fax: 01707 2824810

London Central Region
Tel: 0207 928 6810 Fax: 0207 928 6569

MITSUBISHI ELECTRIC
Changes for the Better

Telephone: 01707 282880

email: ventilation@meuk.mee.com
web: livingenvironmentalsystems.mitsubishielectric.co.uk

UNITED KINGDOM Mitsubishi Electric Europe Living Environmental Systems Division
Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, England
General Enquiries Telephone: 01707 282880   Fax: 01707 278881

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