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Module 1

Domestic ventilation in context

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Module objectives

The aim of this module is for you to appreciate the advantages and disadvantages of each type of domestic ventilation system and their relationship to the Building Regulations.

On completion of this module you should be able to:

- Understand the requirement to ventilate effectively
- Understand the principles of ventilation
- Appreciate energy efficiency in its relationship to ventilation
- Identify the main types of domestic ventilation system
- Identify the advantages and disadvantages of different domestic ventilation systems

Introduction

All dwellings need a supply of fresh outdoor air, not just for the health and comfort of the occupants, but also to control condensation, displace pollutants and to ensure the safe and efficient operation of open-flue appliances. The amount of fresh outdoor air should match the needs of individual dwellings and the people living within it. To achieve an energy-efficient standard of ventilation requires consideration of both the building fabric and the efficiency of the ventilation system. Nowadays, for designs of new or existing buildings under consideration, ventilation should be thought of as part of an integrated design approach for achieving energy efficiency.

Traditionally, many UK dwellings have relied on natural air infiltration to provide ventilation. This can result in excessive ventilation rates that greatly increase energy consumption for space heating, and cause discomfort to occupants from cold draughts.

Energy loss from ventilation accounts for approximately a fifth of space-heating energy demand in older poorly insulated dwellings. In new energy-efficient houses the high insulation levels mean that the proportion of space-heating demand due to ventilation increases to around a third. Equally, natural air infiltration alone can result, at times, in too little ventilation. This leads to poor indoor air quality and other, more readily visible impacts such as condensation damage and mould growth on indoor surfaces.

Why ventilate?

Ventilation is necessary to provide a healthy and comfortable internal environment for a dwelling's occupants. The main task of ventilation is to remove polluted indoor air from a building and replace it with fresh outdoor air.

There are many different types and sources of pollution within the home, for example:

- Moisture e.g. from washing, cooking. On average, per day, each household member is responsible for adding 5 litres of moisture into the indoor air
- Carbon monoxide (CO) and oxides of nitrogen e.g. from combustion appliances, smoking
- Volatile Organic Compounds (VOCs) e.g. from aerosols and formaldehyde found in MDF, new furniture and carpets
- Allergens e.g. from house dust mites. It is mainly the waste product from house dust mites that trigger asthmatic reactions in sufferers.
- Odours e.g. from cooking, body odour, pets
- CO_2 e.g. from humans, pets and also combustion appliances
- Environmental Tobacco Smoke (ETS)

Note: Ventilation is not seen as an adequate means to protect the health of non-smokers in the vicinity of tobacco smoke, because environmental tobacco smoke is a carcinogen and there is no known safe level. Concentrations of benzene, toluene and airborne particulate matter (PM_{10}) can all be expected to be significantly higher in smokers' homes.

Moisture is probably the most significant of household pollutants because of the high rates generated by activities such as cooking and bathing (particularly showering), and because of the associated problems of condensation and mould growth.

Household pollutants

Illustration of dust mites

Example of black mould damage

Research has shown that if relative humidity levels exceed 70% for prolonged periods, there is a high probability that the condensation occurring on cold surfaces will lead to mould growth. Also, it is generally accepted that both house dust mites and black mould thrive at higher humidity levels (>70%RH).

Interstitial condensation is another effect of high levels of humidity. This occurs within the dwelling where warm humid air is allowed to permeate through gaps and cracks in the building fabric. The warm moist air then condenses out on cold surfaces in the dwelling which may cause rotting of timber or corrosion of metal components. Resulting structural damage may occur without visible indications.

In recent years, the airtightness of dwellings has become an issue as part of a drive to provide thermal comfort and reduced energy consumption. However, as dwellings are made more airtight, internal pollutant sources can have a greater impact on indoor air quality and occupants may experience adverse health effects unless the ventilation is effective.

In addition, the emission of pollutants from increased activities in urban areas (most notably from increases in traffic), have led to the outdoor air quality deteriorating. It is therefore important to minimise the levels of pollutants entering the building by effective design and operation of the ventilation. Furthermore in noisy areas it may be appropriate to use sound attenuating background ventilators.

The principles of ventilation

Ventilation is the replacement of indoor air with fresh outdoor air through purpose-provided openings, and through cracks and gaps in the building envelope.

As insulation standards have improved, ventilation heat losses have increased as a percentage of total heat loss. As previously suggested, in well insulated dwellings, the ventilation losses can be responsible for around one third of the total heat loss.

The objective of a good ventilation strategy is therefore, to provide a balance between energy efficiency and indoor air quality. This has led to the concept of 'build tight – ventilate right'. In other words – minimise the amount of uncontrolled air leakage through the building envelope and install a controllable ventilation system to provide the necessary level of ventilation both where and when it is needed.

Approved Document F (Means of ventilation) of the Building Regulations for England and Wales recommends the following three-pronged strategy for ventilation:

Extract ventilation *from rooms where most water vapour and/or pollutants are released, e.g. due to activities such as cooking or bathing. This is to minimise their spread to the rest of the dwelling. This extract may be either intermittent or continuous.*

Whole dwelling/building ventilation *is intended to provide fresh air to the dwelling and to dilute and disperse residual water vapour and pollutants not dealt with by extract ventilation as well as removing water vapour and other pollutants which are released throughout the dwelling e.g. by building materials, furnishings, activities and the presence of occupants.* ***Whole dwelling/building ventilation*** *provides nominally continuous air exchange. The ventilation rate may be reduced when the dwelling is not occupied. It may be necessary to purge the air when the dwelling is re-occupied.*

Whole dwelling/building ventilation is nominally continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour not removed by operation of extract ventilation, purge ventilation or infiltration, as well as supplying air into the building.

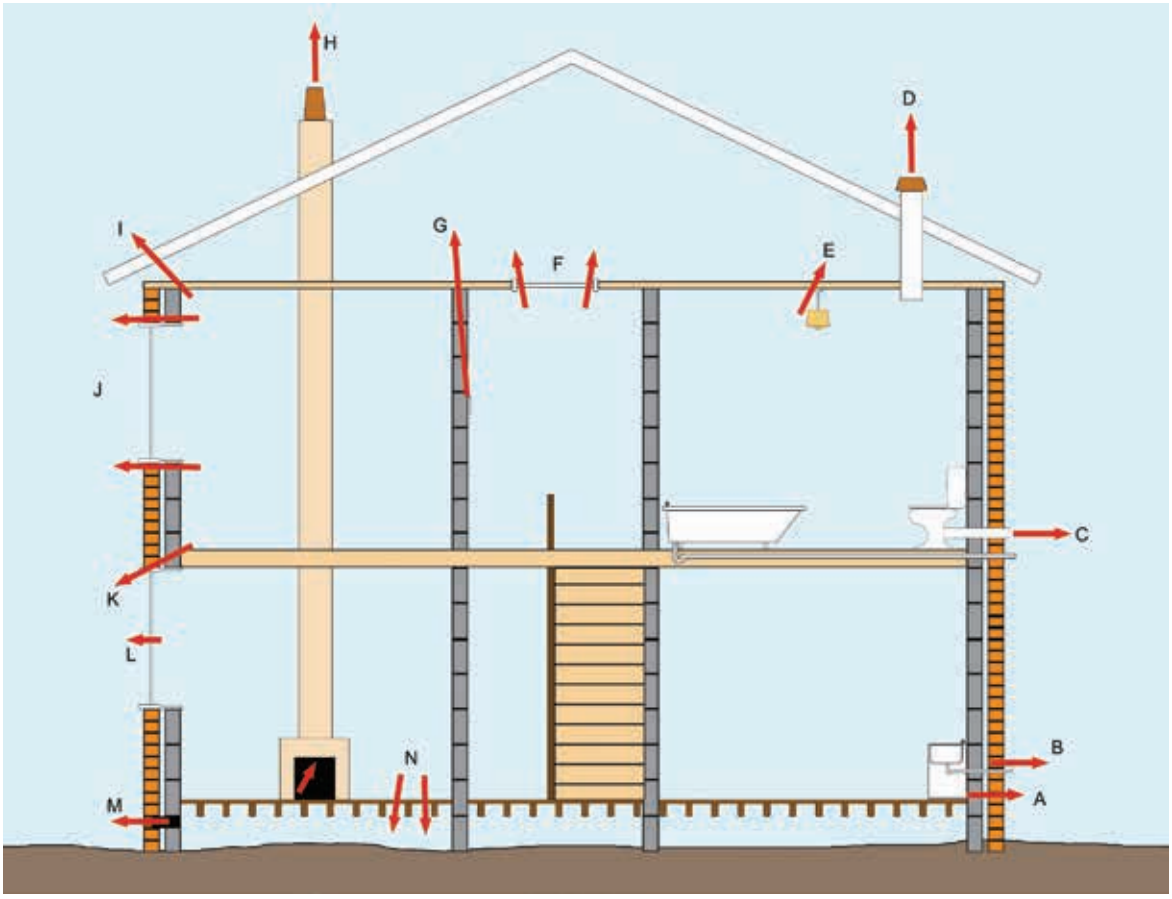
Purge ventilation is manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollutants and/or water vapour. **Purge ventilation** may be provided by natural means or by mechanical means.

Purge ventilation *throughout the dwelling to aid removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental releases such as smoke from burnt food.* ***Purge ventilation*** *is intermittent, i.e. required only when such occasional activities occur.* ***Purge ventilation*** *provisions may also be used to improve thermal comfort.*

Energy efficiency

There are two main ways in which ventilation uses up energy. The major one is the continual need to heat the incoming air (during the heating season) and its subsequent loss as it leaves the building via purpose-provided openings and air leakage. In addition, any form of mechanical ventilation requires electrical power to operate.

Air leakage is the uncontrolled movement of air, both into and out of the dwelling, through the cracks and gaps in the building envelope.



Common leakage paths

A: Gaps between wall and floor, **B**: Gaps around kitchen waste pipes, **C**: Gaps around bathroom waste pipes, **D**: Roof vents, **E**: Ceiling service penetrations, **F**: Gaps around loft hatches, **G**: Gaps in and behind service penetrations, **H**: Open flues and chimneys, **I**: Gaps at eaves, **J**: Gaps around window frames, **K**: Paths through ceiling voids and cavity, **L**: Leaks around window and door seals, **M**: Floor grilles, **N**: Gaps in and around timber suspended floors.

The standard of airtightness achieved within a dwelling will have significant impact on the ventilation rates achieved. Approved Document L (Conservation of fuel and power in new buildings) of the Building Regulations for England and Wales puts a limiting value of 10m^3/(h.m^2) at 50Pa on air permeability (air leakage). In Approved Document F, for the purposes of calculation, a permeability figure of <5 is considered airtight and >5 is considered 'leaky'. It is generally accepted that a figure of <3 is the most appropriate for a dwelling to be fitted with an MVHR system to ensure that the majority of replacement fresh air passes through the heat exchanger. For reference, the German Passivhaus Institut aims to achieve 0.6 in their certified energy-efficient dwellings.

Ventilation rate is the rate at which air within a building is replaced by fresh air. It may be expressed as:

- The number of times the volume of air within a space is changed in one hour (air changes per hour or ach)
- The rate of air change in volume and time, e.g. litres per second (l/s)

The energy efficiency of the ventilation system can be improved by employing mechanical ventilation with heat recovery (MVHR), efficient types of fan motor and/or energy saving control devices in the ventilation system.

Pressure testing of new home

All mechanical systems require electrical power to operate, including power to the fans, transformers and control and safety devices. The term specific fan power is used to compare the total electrical energy use for different ventilation systems as installed i.e taking into consideration duct system resistance.

A well designed ventilation system should minimise this energy usage. In addition, during installation it is important to minimise unwanted pressure losses in the ventilation system. For example, flexible ducting increases flow resistance, so minimising the length used, pulling it taut and keeping duct runs straight, with as few bends and kinks as possible, are all important.

Specific fan power is the power consumption in Watts of the fan divided by the airflow through the system, expressed in Watts per litre per second (W/l/s)

Additionally, an MVHR system will help to reduce the amount of energy needed to heat up the incoming air to room temperature. This benefit must always be balanced against the electrical power requirements needed to drive the process. As noted previously, such systems work best in airtight homes, where almost all of the ventilation takes place via the heat exchanger.

Nowadays, virtually all heat recovery units for dwellings are air to air types. These recover heat from the exhaust air stream and use it to pre-warm the fresh incoming air from outside. The effectiveness of these units is given by its heat exchange efficiency i.e. the proportion of waste heat that is usefully recovered by the process and typically expressed as a percentage.

The amount of ventilation needed in a room depends on the pollution level in that room and, in some cases, whether anyone is present. Automatic controls can be included with all types of ventilation system e.g. humidity sensor, occupancy/usage sensor, detection of moisture/pollutant release. These reduce the level of ventilation if the source of pollution and/or the pollution level is low, and thus save energy.

DOMESTIC VENTILATION CHECKLIST

Competent persons SAP Declaration

Version 1, December 2011

Model Answers