SLOVENSKI STANDARD

SIST-TP CEN/TR 14788:2006

01-junij-2006

Nadomešča:

SIST EN 13465:2004

Prezračevanje stavb - Projektiranje in dimenzioniranje stanovanjskih prezračevalnih sistemov

Ventilation for buildings - Design and dimensioning of residential ventilation systems

Lüftung von Gebäuden - Ausführung und Bemessung der Lüftungssysteme von Wohnungen

Ventilation des bâtiments - Conception et dimensionnement des systemes de ventilation résidentiels

Ta slovenski standard je istoveten z: **CEN/TR 14788:2006**

ICS:

91.140.30	Prezračevalni in klimatski sistemi	Ventilation and air-conditioning systems

SIST-TP CEN/TR 14788:2006 **en**

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 14788

March 2006

ICS 91.140.30

English Version

Ventilation for buildings - Design and dimensioning of residential ventilation systems

Ventilation des bâtiments - Conception et dimensionnement des systèmes de ventilation résidentiels

Lüftung von Gebäuden - Ausführung und Bemessung der Lüftungssysteme von Wohnungen

This Technical Report was approved by CEN on 30 January 2006. It has been drawn up by the Technical Committee CEN/TC 156.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. CEN/TR 14788:2006: E

Contents

Foreword

This Technical Report (CEN/TR 14788:2006) has been prepared by Technical Committee CEN/TC 156 “Ventilation of buildings”, the secretariat of which is held by BSI.

1 Scope

This Technical Report specifies recommendations for the performance and design of ventilation systems which serve single family, multi family and apartment type dwellings during both summer and winter. It is of particular interest to architects, designers, builders and those involved with implementing national, regional and local regulations and standards.

Four basic ventilation strategies are covered; natural ventilation, fan assisted supply air ventilation, fan assisted exhaust air ventilation and fan assisted balanced air ventilation. Combinations of these systems are not excluded and a ventilation system may serve only one dwelling *(individual system)* or more than one dwelling *(central system)*. The ventilation aspects of combined systems (ventilation with heating and/or cooling) are covered.

The ventilation of garages, common spaces, roof voids, sub-floor voids, wall cavities and other spaces in the structure, under, over or around the living space are not covered.

Ventilation systems covered by this Technical Report may affect the entry and dilution of radon and other gases from the ground but these effects are not covered in this Technical Report. Ventilation systems designed to reduce the entry of radon and other gases from the ground are not covered by this Technical Report.

2 References

The following referenced documents are indispensable for the application of this Technical Report. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 779, *Particulate air filters for general ventilation — Determination of the filtration performance*

EN 1507, *Ventilation for buildings — Sheet metal air ducts with rectangular section — Requirements for strength and leakage*

ENV 12097, *Ventilation for buildings — Ductwork — Requirements for ductwork components to facilitate maintenance of ductwork systems*

EN 12236, *Ventilation for buildings — Ductwork hangers and supports — Requirements for strength*

EN 12237, *Ventilation for buildings — Ductwork — Strength and leakage of circular sheet metal ducts*

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13141-1, *Ventilation for buildings — Performance testing of components/products for residential ventilation — Part 1: Externally and internally mounted air transfer devices*

EN 13465, *Ventilation for buildings — Calculation methods for the determination of air flow rates in dwellings*

EN 14134, *Ventilation for buildings — Performance testing and installation checks of residential ventilation systems*

EN 13779, *Ventilation for non-residential buildings — Performance requirements for ventilation and room conditioning systems*

EN 20140-10, *Acoustics — Measurement of sound insulation in building and building elements — Part 10: Laboratory measurement of airborne sound insulation of small building elements (ISO 140-10:1991)*

EN ISO 140-3, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurement of airborne sound insulation of building elements (ISO 140-3:1995)*

EN ISO 10211-1, *Thermal bridges in building construction — Heat flow and surface temperatures — Part 1: General calculation method (ISO 10211-1:1995)*

ISO 9972, *Thermal insulation — Determination of building airtightness — Fan pressurization method*

3 Terms and definitions

For the purposes of this Technical Report, the terms and definitions given in EN 12792:2003 and the following apply.

3.1
activity room
room used for activities such as cooking, washing and bathing which is characterised by relatively high pollutant emission (which may be intermittent), e.g. a kitchen, bathroom, laundry/utility room, WC

3.2
background pollutants
group of indoor pollutants mainly represented by water vapour and carbon dioxide from respiration, but also including a large number of other pollutants emitted by materials, furnishings and products used in the dwelling. Their source rates are relatively low but continuous and diffuse

3.3
common space
corridor, stairway or atrium used for access to a dwelling or dwellings

3.4
cross ventilation (in a natural ventilation system)
natural ventilation in which air flow mainly results from wind pressure effects on the building facades and in which stack effect in the building is of less importance

3.5
fan assisted balanced ventilation
ventilation which employs powered air movement components in both the supply and exhaust air sides in order to achieve a design flow rate/pressure ratio

[EN 12792:2003, 149]

3.6
fan assisted exhaust air ventilation
ventilation which employs powered air movement components in the exhaust air side only

[EN 12792:2003, 150]

3.7
fan assisted supply air ventilation
ventilation which employs powered air movement components in the supply air side only

[EN 12792:2003, 154]

3.8
low pollution room
room used for dwelling purposes which is characterised by relatively low pollution emission, e.g. a bedroom, living room, dining room, study, but not a space used only for storage

3.9
outdoor air
controlled air entering the system or opening from outdoors before any air treatment (coded green)

[EN 12792:2003, 280]

3.10
natural ventilation system
ventilation system which relies on pressure differences without the aid of powered air movement components

3.11
specific pollutants
group of indoor pollutants mainly represented by water vapour, carbon dioxide and odours, whose production is related to specific human activities in the dwelling (such as cooking, washing, bathing). Their source rates are relatively high but of short duration, and in specific locations in the dwelling

3.12
stack effect
movement of air or gas in a vertical enclosure (e.g. duct, chimney, building) induced by density difference between the air or gas in the enclosure and the ambient atmosphere

3.13
standard air
atmospheric air having density 1,2 $kg \cdot m^{-3}$ at 20 °C, 101 325 Pa (1 013,25 mbar) and 65 % relative humidity

[EN 12792:2003, 340]

3.14
ventilation
designed supply and removal of air to and from a treated space

[EN 12792:2003, 388]

3.15
ventilation flow rate
volume flow rate at which ventilation air is supplied and removed

[EN 12792:392]

NOTE Normally uses standard air condition.

3.16
ventilation installation
combination of the ventilation or air conditioning installation and the building itself

3.17
ventilation system
combination of all components required to provide ventilation

NOTE The definitions 3.16 and 3.17 are the reverse of those given in EN 12792 and reflect the terms in more common usage in the industry.

4 Symbols and units

For the purpose of this Technical Report, the symbols and units given in EN 12792:2003 apply.

5 Need for ventilation in dwellings (residences)

5.1 General

A supply of outdoor air in buildings is normally regarded as being required for one or more of the following purposes:

a) dilution and/or removal of background pollutants such as substances emitted by furnishings and building materials and cleaning materials used in the building, odours, metabolic CO_2 and water vapour;

b) dilution and/or removal of specific pollutants from identifiable local sources such as toilet odours, cooking odours, water vapour from cooking or bathing, environmental tobacco smoke, combustion products from fuel burning appliances;

c) provision for occupants for respiration;

d) control of internal humidity;

e) provision of air for fuel burning appliances.

These purposes are all with regard to the health of the occupants and the building. Ventilation is primarily concerned with the first four purposes (a) to d)) but it is linked to the last one (e)). In providing ventilation it is important to also consider other aspects of performance including thermal comfort, durability, fire safety, noise and energy use.

5.2 Composition of outside air

The proportions of the three main elements of outside air, oxygen (20,9 %), nitrogen (79,0 %) and carbon dioxide (0,034 %) do not vary significantly in outside air. Carbon dioxide may be found at higher concentrations in built-up areas and may be high enough to affect ventilation provision.

The main variable constituent of outside air is water vapour. Across Europe the typical specific moisture ranges from 1,0 g up to 16 g moisture per kg dry air during yearly weather conditions (see Annex B for further information).

However, in some situations the concentrations of other outdoor pollutants (mainly pollutants from motor vehicles in city areas) may reach unacceptable levels. The designer may wish to consider filtration of outdoor air by adding filters to the ventilation system. At present it is generally only practicable to provide filters for particulate matter.

5.3 Dilution and removal of indoor pollutants

A wide range of airborne pollutants is generated by sources within dwellings, including gases, vapours, tobacco smoke, biologically inert particulates (e.g. dusts and fibres) and viable particulates (e.g. fungal spores, viruses and bacteria). Such pollutants may have the potential to harm the health or comfort of occupants or may lead to damage to the dwelling fabric.

Indoor pollutants may be divided into three groups: specific pollutants which can be substantially removed by local ventilation close to identifiable local sources; background pollutants which have diffuse sources or for other reasons cannot be dealt with by local ventilation; and combustion products from fuel burning appliances (combustion products are discussed in 5.6 and 7.3).

Production rates of pollutants are best known (or predicable) where the source is combustion or where the pollutant results from the presence or activities of occupants. Production rates are less well defined where the source is related to the fabric or furnishings of the dwelling.

At present there is no consistent approach to setting acceptable indoor concentrations for many of the diverse source pollutants in dwellings, however, in the general case they are believed to be adequately removed by ventilation for those few pollutants whose source rates and acceptable levels are known. The known pollutants are discussed in the following subclauses.

5.4 Human respiration

The body requires oxygen for the production of energy at a rate proportional to metabolic rate. However, the main limiting factor is not the supply of oxygen but the build-up of water vapour and carbon dioxide in expired air, whose production rates from human respiration are given in Annex A.

5.5 Control of indoor humidity

The relative humidity of air is equal to the ratio of the partial vapour pressure in the air to the partial pressure of water vapour in saturated air at the same temperature. Low relative humidities (below approximately 30 %) can give rise to respiratory discomfort and nuisance from electrostatic effects. High relative humidities (above approximately 70 %) incur the risk of condensation and mould growth on surfaces that have temperatures close to or below the dew point temperature of the air. In very cold climates it may be desirable to reduce ventilation rates, and tolerate consequent higher CO_2 levels, in order to avoid relative humidity being uncomfortably low (below approximately 30 %). The concentrations of pollutants (including CO_2) in the dwelling may then rise to unacceptable levels in which case increased ventilation air flow rates can become necessary.

The contribution made by ventilation is to lower the moisture content of the internal air by dilution with outside air which normally has a lower absolute moisture content (as described above, relative humidity of the outside air is reduced when it is heated to indoor temperatures). In cold climates (e.g. central and northern Europe) the problem tends to be low indoor humidity. In temperate climates (e.g. European maritime areas) the problem tends to be high indoor humidity.

For any required indoor humidity level the air flow rate required depends upon the moisture content of the outside air, the rate of moisture input (from such sources as respiration, cooking, bathing, clothes drying and flue-less combustion of certain fuels), the indoor air temperature, the temperature of surfaces in the room(s) and the water vapour absorption characteristics of surfaces and furnishings in the room(s). The latter is discussed in Annex B and Annex C.

Typical moisture generation rates for some common household activities are given in Annex A. It should be noted that these are only a guide because they are strongly dependent upon the habits of the dwelling occupants.

Depending on the type of ground floor construction water vapour can also enter dwellings in significant quantities from the ground. The designer should take it into account when appropriate (see Annex A and national or local building regulations).

5.6 Provision of air for non sealed fuel burning appliances (open flued appliances)

An air supply to a non sealed fuel burning appliance is required for one or more of the following purposes:

a) to supply air for correct combustion and flue operation;

b) to limit the concentration of combustion products within the spaces to an acceptable level (normally taken to be a maximum of 0,5 % carbon dioxide and relative humidity low enough to avoid condensation leading to mould growth);

c) to prevent overheating of the appliance and its surroundings. Carbon monoxide (CO) may also be produced by fuel burning appliances but should be dealt with by correct adjustment of burners and by providing adequate air supply to limit CO_2 concentration and avoid its conversion to CO.

NOTE Room-sealed and balanced-flue type appliances do not require air for a) or b) but may require ventilation air for c).

It is strongly recommended that flue-less space heating appliances are not used in dwellings because of their high CO_2 and water vapour output rates and their high air supply requirement. Flue-less cooking appliances are acceptable because of their relatively low fuel use and intermittent use. In some countries national regulations may forbid the use of flue-less space heating appliances.

Air supply to prevent overheating of the appliance is considered to be a heating issue, not a ventilation issue, and should not be discussed further.

When designing a ventilation system there are two distinct problems to consider with respect to fuel burning appliances: (i) avoiding spillage from open flued appliances and, (ii) dilution of pollutants from flue-less appliances. For correctly designed and installed appliances with flues or chimneys all the combustion products should be discharged directly to outside. For this to happen it is important that the ventilation system does not cause spillage of combustion products by significantly depressurizing the room. Ventilation systems can be designed to remove ventilation extract air and combustion products by the same duct system and fan. In such systems it is essential that safety controls are included to ensure that a failure of the exhaust fan does not result in spillage of combustion products into any dwelling.

Ventilation to limit the concentration of combustion products in the indoor environment should only be applicable to flue-less combustion appliances. These appliances may be categorized as (a) continuous (such as kerosene or gas space heaters) or (b) intermittent (such as gas water heaters and cookers).

The criteria most usually applied in assessing the required ventilation rate for flue-less appliances is the need to maintain the concentration of carbon dioxide below the widely accepted occupational (8 h) exposure limit of 0,5% and indoor relative humidity low enough to avoid condensation leading to mould growth. For continuously operating appliances an equilibrium condition is appropriate but for gas appliances which operate intermittently for limited periods of time a lower air supply rate is permissible. CO_2 and water vapour production rates for fuels commonly used in flue-less appliances are given in Annex A.

NOTE In some countries other criteria may dominate that for CO_2, such as particularly low limiting concentrations of formaldehyde or oxides of nitrogen.

6 Design assumptions for residential ventilation

A ventilation system is designed to provide outdoor air for human and building needs under certain defined conditions. The design performance of a ventilation system can only be achieved within the limits of these conditions. It is essential that the designer specifies these conditions as well as the design performance of the ventilation system.

External environmental and climatic conditions may influence the application of different ventilation principles.

EXAMPLE 1 A slight under-pressure in relation to outdoors especially in severe climates can help to avoid damage to structures caused by moisture.

EXAMPLE 2 In areas where under-pressure can cause the potential risk of an increase in the concentration of radon, the under-pressure indoors should be designed to be a minimum.

EXAMPLE 3 Alternatively, the building can be designed for slight overpressure if the building structures, indoor air humidity and climate conditions are suitable. Special attention should be given to the risk of condensation and moisture damage.

The designer should consider making assumptions about the following:

- outdoor meteorological conditions (e.g. wind speed, air temperature, humidity) which might be expressed as extreme values, average values, value exceeded for a percentage of the time, and may be on a monthly or yearly basis;
- pollutant levels in the outdoor air;
- outdoor noise level;
- shielding of the building;
- air-tightness of the building;
- thermal characteristics of the building;
- noise characteristics of the building (walls, windows etc.);
- maximum acceptable pollutant levels in the indoor air;
- thermal comfort;
- acoustic comfort;

- number of occupants the rooms and/or dwelling are designed for;
- indoor pollutant production rates;
- noise from the ventilation system;
- proper installation of the ventilation system/components (e.g. duct leakage);
- proper use of the ventilation system/components (e.g. running times);
- proper cleaning and maintenance of the ventilation system/components.

These resulting design conditions should be listed in the specification for the system and the operating manual for the ventilation system (see Clause 9). Guidance on the proper use and maintenance of the ventilation system is a particularly important part of this manual.

7 Performance requirements for ventilation systems

7.1 Ventilation air volume flow rate

7.1.1 General

The ventilation system should be designed to provide ventilation according to the performance requirements and design rules given in Clauses 7 and 8. Informative Annex D may also be a useful source of general information and guidance on residential ventilation and air-tightness.

For all residential ventilation systems it is necessary to specify ventilation air volume flow rates such that assumed or predicted concentrations of certain known indoor pollutants are not exceeded. The ventilation air volume flow rate is specified in many different ways in the regulations and standards of different countries and it has not been possible to draw up a simple table with classes which cover all, or even most, of the widely varying requirements and options currently used in European countries. Therefore, this Technical Report does not contain mandatory requirements or classes for residential ventilation air flow rates. The required ventilation air flow rates should be obtained from national and local regulations and/or standards prevailing in the country concerned.

However, this Technical Report does describe a method of establishing the required ventilation air volume flow rate by calculation using pollutant production rates and indoor and outdoor air conditions specified by the user. The equations for use in the calculation method are given in Annex E. Examples of the ventilation air flow rates resulting from such calculations are given in Annex F on the basis of a range of assumptions about pollutants and other parameters.

7.1.2 Pollutant groups

The most common pollutants occurring in dwellings may be grouped into three different groups which can lead to different, but complementary, ventilation strategies.

a) Group of background pollutants. Two types:

   - first type includes a large number of pollutants emitted by materials, furnishings and products used in the dwelling. They are generally not perceivable by the occupants and their sources are at a relatively low but continuous rate;
   - second type includes metabolic products from the occupants mainly represented by water vapour and carbon dioxide from respiration, and odours;

b) Group of specific pollutants, mainly represented by water vapour, carbon dioxide and odours. Their production is related to specific human activities in the dwelling such as cooking, washing, bathing etc., whose duration is relatively short, which result in relatively high pollutant production, and which occur in specific locations in the dwelling;

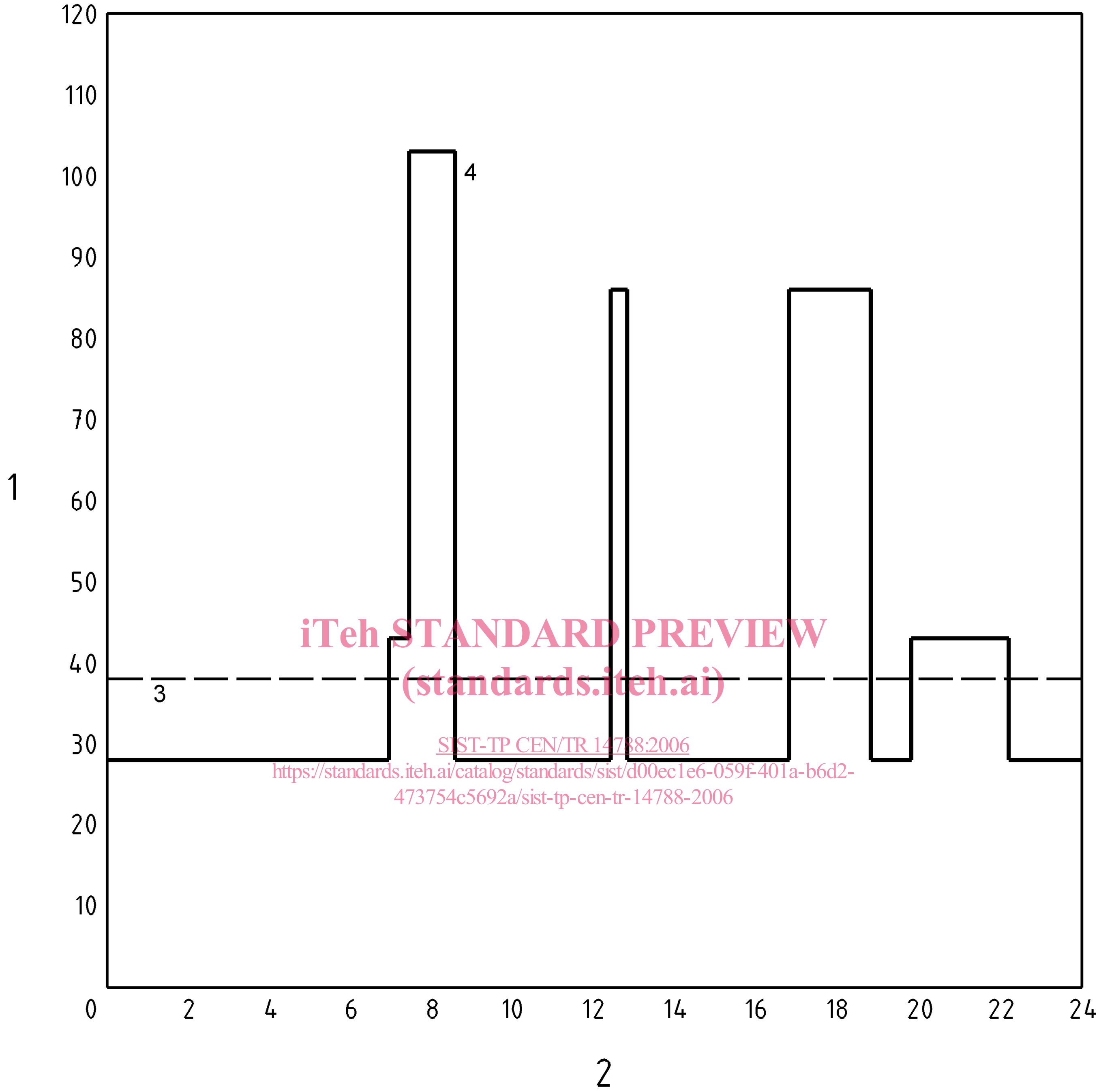
c) Group of combustion products from fuel burning appliances for space and water heating, the most dangerous of which is carbon monoxide. These should be dealt with by proper design of the appliance and a chimney or flue system which carries the pollutants directly to outside the dwelling, if possible.

NOTE it is strongly recommended that flue-less space or water heaters are not used in dwellings because of their high rates of pollutant production.

For residential ventilation purposes it is common to use water vapour as an indicator of ventilation need in activity rooms. In low pollution rooms both water vapour and CO_2 are used as indicators of other metabolic pollutants.

7.1.3 Ventilation strategies

One of the following two ventilation strategies are normally used. First, a continuous and nominally constant ventilation air flow rate may be provided to deal with both specific and background pollutants together. Alternatively, a continuous (relatively low) background ventilation air flow rate may be provided to deal with the background pollutants together with a higher intermittently operated extract air flow rate provided in the activity rooms to deal with most of the specific pollutants. The intermittent operation may be controlled manually by the occupant or automatically by suitable sensors. A typical pattern of intermittent operation over a period of one day, compared with an equivalent extract system operating continuously at a constant rate, is illustrated in Figure 1.



Key

1 total air ventilation air volume flow rate (L/s)

2 time of day (hours)

3 continuous extract ventilation at constant rate

4 intermittent extract and natural background ventilation

Figure 1 — Example of two ventilation strategies

7.1.4 The ventilation air volume flow rate requirement

In all cases the basic intention is to achieve a reasonable level of indoor air quality without wasting energy, i.e.

i) CO_2 concentration to be kept below a reasonable level;

ii) humidity is kept between reasonable levels to avoid an atmosphere which is too dry and to avoid mould growth or condensation;

iii) to remove odours within a reasonable time;

iv) to keep concentrations of other unspecified pollutants below a reasonable level.

Considering the diversity of sources and pollutants in indoor air, and the range of susceptibility in the population, compliance with this Technical Report will not necessarily ensure acceptable indoor air quality for everyone. There may be a conflict between the above criteria; e.g. the ventilation rate to keep below a particular CO_2 level may lead to a level of humidity which is too low to be acceptable. Compromises may then have to be made allowing some pollutant concentrations to rise above intended limits for a limited period.

When determining ventilation air flow rates the total design extract air flow rate and the total design supply air flow rate obtained for the whole dwelling are usually different. The ventilation system should generally be designed to extract air at the greater of those two air flow rates to avoid overpressure and the risk of interstitial condensation in the structure. The ventilation system should be designed to supply air at least to the design total supply air flow rate. The difference between the design total supply and extract air flow rates may be provided by air leakage through the dwelling structure and/or by additional air supply components in the ventilation system. As buildings are getting tighter and tighter, relying only on building leakage could lead to too low ventilation rates.

If air leakage alone is used for the additional air supply then there may be problems with spillage from open-flued combustion appliances in airtight dwellings (see 7.1.9).

Where products intended for high flow intermittent operations, e.g. range hoods, drying machines, consideration should be given to the replacement air requirements.

7.1.5 The calculation method

The starting point for the calculation method is to define the most important, or key, pollutants in each type of room in the dwelling. It is assumed that if the key pollutant is adequately controlled then other pollutants in that room are also adequately controlled. In some rooms it may not be clear which is the key pollutant until some calculations have been made. Key pollutants for various room types are as follows:

Low pollution rooms: CO_2 (metabolic) or water vapour;

— kitchen: water vapour, odours, CO_2 (from combustion of fuels);

— bathroom: water vapour;

— WC: odours;

— laundry/utility room: water vapour.

Other pollutants can be released during specific activities, such as vapours from paints and adhesives used as part of a hobby. If known these may be included in the calculation method.

Pollutant emission rates should be calculated for each room separately based on either known emission rates (where available) or the data given in Annex A. This may require assumptions about the number of occupants in the dwelling, the type and rating of combustion appliances, and occupant habits (clothes washing, cooking, bathing etc.).

7.1.6 Minimum and maximum ventilation air flow rate

Minimum ventilation airflow rate is intended to ensure that a minimum level of air quality is maintained by removing pollutants which are continuously emitted from materials and activities in the dwelling, removing residual pollutants (particularly water vapour) after occupation ceases, and to reduce the risk of a build-up of condensation in ventilation ducts. There may be different minimum air flow rates for when the dwelling is occupied and when it is