Ventilation of dwellings in the Dutch energy performance standard

The role of ventilation and air tightness

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1. Introduction

The NEN 5128 "Energy performance of dwellings and residential buildings- Determination method" [1] describes a procedure to calculate the energy performance coefficient EPC. The requirements are given in the Dutch Building Decree [2].
The energy performance is expressed as an **E**nergy **P**erformance **C**haracteristic (EPC).
In this EPC procedure ventilation and air tightness play an important role. This paper describes the role of ventilation and air tightness in the Energy Performance Standard. Moreover it gives the alternative way of the so called equivalence principle.

2. Energy Performance Characteristic

The EPC is a calculated energy use for a certain building divided by a reference value.[3]

For dwellings it is calculated as:

$$\mathbf{EPC = Q_{perf} / Q_{ref}}$$

where:
Q_{perf} = the energy performance of the dwelling in MJ
Q_{ref} = the energy use of a reference dwelling in MJ

$$Q_{perf} = Q_{heat} + Q_{fan} + Q_{........}$$

where
Q_{heat} = the energy use for heating
Q_{fan} = the energy for fans
$Q_{.......}$ = the energy for several other aspects

The other aspects such as the energy use for domestic hot water use, pumps, gains etc., which are described in [3].

$$Q_{heat} = Q_{trans} + Q_{vent} - Q_{gains}$$

where

Q_{trans} = the energy use for transmission losses through the envelope
Q_{vent} = the energy use due ventilation and infiltration
Q_{gains} = the energy gains due passive solar and internal gains

This paper is mainly dealing with ventilation and infiltration losses.

$$\mathbf{Q_{ref} = 330A_g + 65\ A_{loss}}$$

where
A_g = floor area of the dwelling in m^2
A_{loss} = area of the outside envelope of the dwelling in m^2

The constants 330 and 65 are fixed values.

3. Ventilation

The ventilation part can be divided into two parts:

- The flow due to the ventilation system
- The flow due to the air tightness of the building

The flow due to the ventilation system is regardless the type of ventilation system the same value

The heat loss due to ventilation can be calculated with:

$$Q_{vent} = H_{vent} * 238$$

where:
Q_{vent} = the energe consumption for ventilation in MJ
H_{vent} = the specific energe consumption for ventilation in W/K
238 = the time accumulated temperature difference in K. Ms

$$H_{vent} = 1.2 * q_v$$

where:
q_v = the ventilation flow rate in dm^3/s
1.2 = specific heat kJ/dm^3

For the flow rate to be taken into account the following equation is used:

$$q_v = 0.47\ A_g + 0.13\ q_{v10}$$

where:
A_g = floor area of the dwelling in m^2
q_{v10} = air tightness of the dwelling dm^3/s at a pressure difference of 10 Pa

The constants 0.47 and 0.13 are constants to be derived from an extensive multi zone model study for Dutch houses.
The values of 0.47 and 0.13 are fixed values and has to be chosen unless one can prove along the lines of the equivalence principle that another value can be taken. See chapter 4.

Example

Floor area $A_g = 100\ m^2$
Air tightness of the dwelling $q_{v10} = 100\ dm^3/s$
q_v = (0,47 x 100 + 0,13 x 100) = 60 dm^3/s,
H_v = 1,2 x 60 = 72 W/K
Q_{vent} = 72 x 238 = 17136 MJ

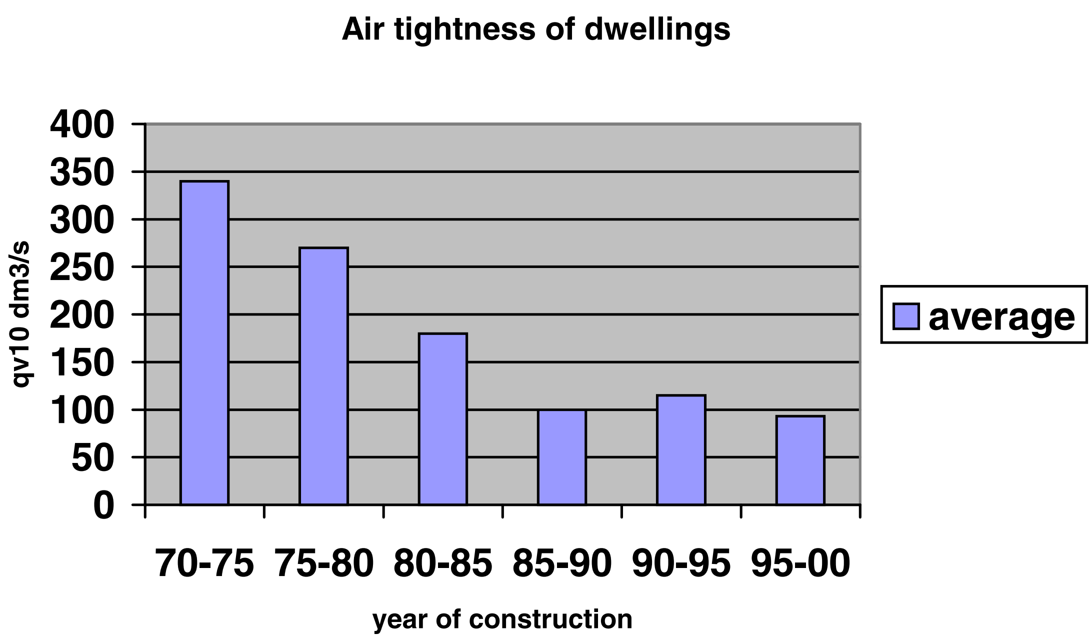
3.1 Infiltration

The infiltration losses are of course determined by the air tightness of the building.
The infiltration part of the equation is **0.13 q_{v10}**.

The relation between q_{v10} and the N_{50} value can be expressed as
$N_{50} = q_{v10} / 25$
So an q_{v10} of 100 equals a N_{50} value of about 4, depending on the building volume and the flow exponent *n*.
The air tightness requirement for a dwelling is q_{v10} is 200 dm^3/s at a pressure difference of 10 Pa, which equals a N_{50} value of about 8.

The air tightness of Dutch single family houses over the last year has strongly improved.

Figure 1 The air tightness of dwellings against year of construction.



The improvements since 1970 till now is very good. The air tightness level nowadays is three to four times better than in 1970. The last years it seems to stabilize but in fact the dwellings are becoming larger, so the specific air tightness is still improving. The EPC calculation have to be made at the moment that the building permit is being asked. So each applier for a building permit should estimate the building air tightness from experience. To help people to estimate the air tightness an appendix to the standard give some assistance.

$$q_{v10} = 0.5 * C1 * C2 * C3 * A_{loss}$$

where

C1 = constant for the construction type
C2 = constant for the roof type
C3 = constant for the construction quality
A_{loss} = area of the outside envelope of the dwelling in m^2

Construction type	**C1**
Brickwork/masonry	2
Concrete	1
woodframe	1.3

Roof type	**C2**
Roof with pitch	1.7
Flat roof	1.0

Construction quality		**C3**
Good	All details specified according to SBR 200	0,5
Normal	All details specified, information on tightening available	1
Poor	No details available	2

The constants C1, C2 and C3 are resulted from measurements in practice. With this help one can make a very rough estimation on air tightness. Better is to have measured data available from comparable dwellings built by the same builder.

3.2 Ventilation

The ventilation part of the equation is $\mathbf{0.47\ A_{loss}}$.
For an A_{loss} of 100 m^2 the flow rate is 47 dm^3/s.

These ventilation losses are divided in three parts:

- The assumed flow through the ventilation system
- The extra flow due to the use of the ventilation provisions
- The flow due to airing

The assumed flow through the ventilation system is 36 dm^3/s.
The assumed flow due to the use of the provisions is 7.4 dm^3/s
The assumed flow due to airing 3.6 dm^3/s

In case of innovative ventilation systems such as demand controlled hybrid ventilation the equivalence principle have to be proven. See chapter 4

3.3 Energy consumption for mechanical ventilation

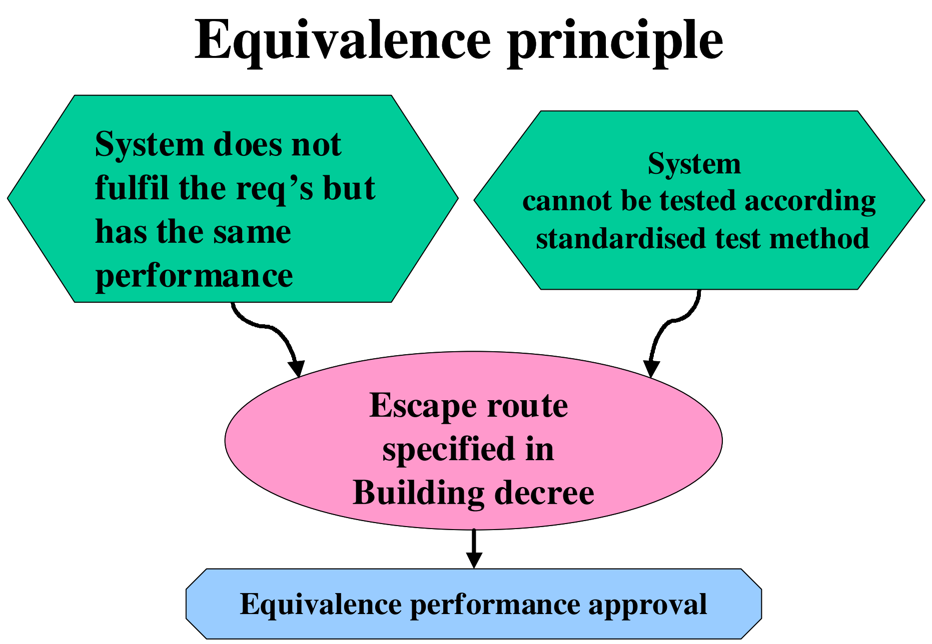
The energy use due to mechanical fans can be calculated directly from the fan power.

Q_{fan} = 32 x P_{eff} / η_{el}
where
P_{eff} = the effective power in W
η_{el} = the efficiency of the electricity
32 is derived from the the time which is a full year in hours 8760h and a conversion factor from Wh.

Q_{fan} = 32 x 15/0,39 = **1231 MJ**

4. Equivalence principle

In case one want to prove the same performance as required without using the same type of expressions or in case one use the determination method because it is not fitted to his ventilation system the equivalence principle may be used. See figure 2.



An extensive study taking into account all possible effects should be studied. In case of a demand controlled ventilation system this study consists of:

- a multi zone model study with the same input as published as basis for the Energy performance requirements and determination method.
- the output is a number of figures to show at least the same indoor air quality levels as in the reference case
- as well as the energy performance at that flow levels according to the demand controlled system.

As an example TNO has studied a demand controlled system for which the determination method was not suitable.
The equation in the determination method for ventilation could be changed from:

$$q_v = 0.47\ A_g + 0.13\ q_{v10}$$

to

$$q_v = 0.29\ A_g + 0.12\ q_{v10}$$

For q_{v10} of 100 dm^3/s and A_g of 100 m^2 this leads to air flows rates to be taken into account of 60 dm^3/s and 41 dm^3/s. The saving in flow rate was hence 19 dm^3/s. The effect on the EPC was about 0.13 on an absolute level of the EPC of about 1.1 which is an effect of about 12 %.

5. References

[1] NEN 5128
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