Ventilation in residential buildings: A comparison of different calculation methodologies in the context of the EPBD

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Abstract:

The legal background for the assessment of the energy performance of buildings and energy certificates in Germany will be changed in October 2009. Beside the tightening of the requirements by about 30%, a significant change will be made at the calculation of residential buildings. Up to now the calculation has to be performed by using the so-called simple approach (EN 15603) by applying the outdated European standard EN 832 in combination with the European Standard EN 14335 with national boundary conditions. From October the calculation can also be performed according to the so-called holistic approach (EN 15603) by applying the DIN V 18599, the German standard application of the EPBD related CEN standards from the EU mandate 343.

The DIN V 18599 differentiates the calculation into mechanical ventilation, natural ventilation by opening the windows and ventilation due to infiltration through leakages. That means that the energy effort in residential buildings for ventilation can now be considered in a much more detailed level.

In this paper two typical residential buildings are calculated with various configurations of the ventilation system. This might be as well a mechanical ventilation system with heat recovery but also only naturally ventilated buildings. This work will give an overview, whether the energy performance and especially the energy for ventilation are significantly different, when calculated with the two standards.

KEYWORDS

Energy efficiency, Standard, Ventilation, Residential Building; EPBD; Calculation Methodology

INTRODUCTION

The Ventilation has an impact on the energy demand of a building. This is a known fact. But how is the ventilation considered within the calculation of the energy demand? With the introduction on the in 2009 updated ordinance on Energy Efficiency in Buildings (Energieeinsparverordnung – EnEV) two different calculation methodologies are possible. The new approach with the calculation of the energy demand according the DIN V 18599, new techniques and possibilities especially for mechanical ventilation and cooling are available.
Since the older approach focuses only on heating energy, mechanical ventilation was only regarded from that perspective. So on the one hand, there are not that many possibilities available, but on the other hand even more important, the hygienic

necessary air volume flow is now considered. So the new standard goes beyond the scope of only looking at the heat energy demand.

THE SIMPLE APPROACH

The simple approach according EN 15603 is applied in the German DIN V 4108-6 and DIN V 4701-10. In DIN V 4108-6 the heat energy demand (this term changed in the new standard to net energy for heating) is calculated and it adopts the outdated European standard EN 832 as well as the European Standard EN 14335 in addition with national boundary conditions. The DIN V 4701-10 describes the calculation methodology for heating and ventilation systems in the building. Both standards do not take cooling into account, as most of the residential buildings in Germany are not mechanically cooled. There are different other standard dealing for instance with a maximum solar gain through windows to prevent overheating in residential buildings.
For the calculation of the primary energy demand of a building it is separated into two parts, the building itself and its systems. Both parts are calculated separated from each other, and for both parts there are even more simplified methodologies available.
The easy to use simplified approach for calculating the heat energy need for a building over a fixed period of 185 days is popular by designers. This is the so called heating period balancing. For energy certificates usually the more accurate approach with a balancing of heat gains and losses on a monthly basis is used.
The heating and ventilation systems can be calculated with three possibilities, the very simple diagram method, where out of a selection of 101 pre-configurations (but fixed solutions) combining the heating, domestic hot water (DHW) and ventilation systems, the effort factor (ep) is directly given. With that effort factor, the primary energy demand can be simply calculated by heat plus DHW energy demand times the effort factor. The effects of a heat recovery system may not be considered in calculation of the heat energy demand, as this is included already in the effort numbers.
There are two more detailed methods available, where the components (e.g. the boiler, the storage, etc.) are calculated either with standard values (tabular method) or with known figures for the single components (detailed method).
There are interactions between the building and its systems, but they only decrease the heat energy demand by a certain amount. The internal gains and/or losses form the systems, that influence the balancing itself are not considered.
Ventilation is basically only differentiated between natural and natural ventilation, as especially the influences of the different user behaviours are not considered in this standard and not all ventilation systems could be calculated without the interaction between building and systems.

Natural Ventilation

The air change rate is the only parameter for the calculation of the specific ventilation heat losses for natural ventilation. The air change rate is influenced by the air tightness of the building. If there has been no air tightness test or the air change rate at a pressure difference of 50 Pa exceeds 3 h^{-1}, the standard air change rate is n = 0,7 h^{-1}. If the test was passed, the standard air change rate is n= 0,6 h^{-1}.

Mechanical Ventilation

Mechanical systems are mainly differentiated in system with exhaust air, with supply air or both.
Exhaust air systems can also have a heat pump. If the mechanical ventilation provides supply and exhaust air, the system can be configured with a heat recovery system, with a heat pump or with a heat register for the supplementary heating of the air.
There are some restrictions in the calculation as for instance in the very simple diagram method, the heat recovery rate is either fixed at 60% or 80%. The higher recovery rate may only be used, if the other components of the HV system are considered as energy efficient.

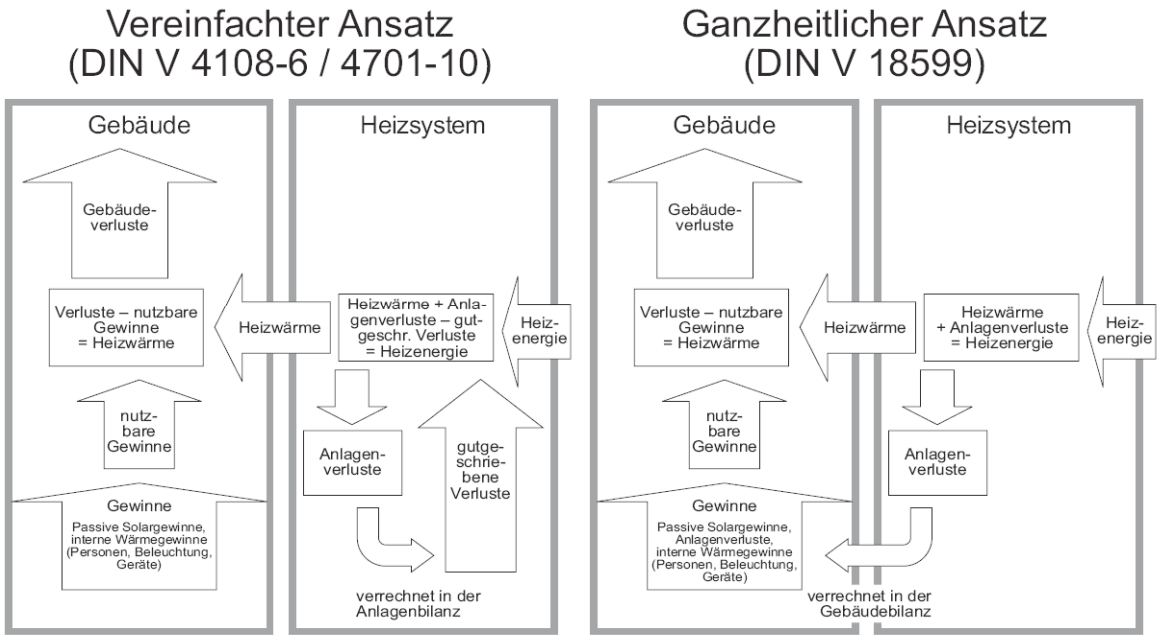

Figure 1: Methodology of the calculation of the energy demand with the simple and the holistic approach.

HOLISTIC APPROACH ACCORDING DIN V 18599

The European Energy Performance Building Directive forced the member states of the European Union to implement an energy performance calculation methodology, which takes into account all relevant energy demand shares that are directly related to the conditioning of a building. This implementation is realised with the DIN V 18599 in Germany. The existing approach in Germany has to be changed, as it did not include lighting and cooling and has several restrictions like fixed heating seasons. The consideration of mechanical ventilation was also reworked. The standard consists of 10 parts.

Figure 2: DIN V 18599 Parts of the Standard.

Compare to the former (simple) approach, there are several major changes in the methodology. One of those changes is the combined calculation of the building itself and its systems. Due to that fact, heat gains and losses of the emission, distribution, storage and generating for the heating, ventilation and cooling (HVAC) systems can be also taken into account in the balancing of the building's net energy.
Another major change is the multi zone model. The single zones are determined by their usage and their conditioning. The user profiles, which are attached to these zones, provide now also hygienic requirements, especially for ventilation, where a minimum air volume flow to outside must be fulfilled.

Ventilation

The ventilation of a building is covered in the Part 2 (Energy need for room heating and cooling), Part 3 (Energy need for air-conditioning), Part 6 (Final energy for ventilation systems for dwellings), Part 7 (Final energy for air-conditioning and cooling) and Part 10 (Boundary conditions).

There are two major changes in the calculation of the energy needs. For the balancing of heat sources and sinks, the ventilation is no longer considered as a general influence, but divided into the parts infiltration, ventilation by the windows and mechanical ventilation. If the air is supplementary heated and/or cooled, the energy demand for heating up or cooling down the outside air, the energy demand is calculated according part 3 of the standard. The heated and/or cooled air is now then going into the balancing of the energy needs as sinks or sources depending on their setpoint temperature.

ORDINANCE ON ENERGY EFFICIENCY (ENERGIEEINSPARVERORDNUNG)

The holistic approach was introduced for the calculation of the energy performance of buildings in 2007 with the ordinance on energy efficiency in buildings, the so called Energieeinsparverordnung (EnEV). There is a renewal of that ordinance in October 2009. Besides the tightening of the requirements by approximately 30%, the holistic approach is now also allowed for residential buildings

Before the holistic approach was introduced, the requirements for a building were defined depending on the ratio of the heat changing surface to the heated volume. As especially in non-residential buildings, there is no common maximum value for buildings only depending of their shape, the so called reference building methodology was given. The building is no longer compared to fixed values, but calculated again with the same geometry and usage, but the building envelope and the building systems are replaced with reference technologies. The calculation of that reference building now gives the maximum amount of primary energy, that that building may use. Especially for ventilated buildings, this is quite important as such buildings usually need more energy than naturally ventilated buildings.

COMPARISON OF CALCULATED ENERGY DEMAND WITH THOSE TWO STANDARDS

The two calculation methodologies are applied in a residential building with two living units. The building is heated but not cooled as the simple approach can only calculate heating demand. The system has a combined condensing boiler with system temperatures of 55°C/45°C for space heating and domestic hot water.

Table 1 shows the calculated demand values according the simple approach with DIN V 4108-6 in combination with DIN 4701-10.

	Q_P kWh/m²a
Natural ventilated	
no air tightness test	73,40
with air tightness test	68,60
Mechanical ventilated	
only exhaust air	71,60
mechanical ventilation with heat recovery	60,00

Table 1: Calculation results of different ventilation strategies with the simple approach.

Table 2 shows the calculated demand values for a calculation according DIN V 18599.

	Q_P kWh/m²a	$Q_{heat,P}$ kWh/m²a	$Q_{DHW,P}$ kWh/m²a	$Q_{vent,P}$ kWh/m²a
Natural ventilated				
no air tightness test	**87,20**	53,70	33,50	0,00
with air tightness test	**81,60**	48,00	33,60	0,00
Mechanical ventilated				
only exhaust air	**81,70**	48,10	33,60	0,00
mechanical ventilation with heat recovery	**119,70**	46,80	33,60	39,30

Table 2: Calculation results of different ventilation strategies with the holistic approach.

The new holistic approach of DIN V 18599 allows one to calculate the influences of a mechanical ventilation system much more detailed. And it shows that the older approach was not sufficient, if one uses the air-conditioning system for space heating. Also the variety of systems, that can be calculated with the two standards are significantly different.
But as one can see in Table 2, this also may rise some problems. The holistic approach needs some understanding of the calculation method and especially if one wants to compare the results of the two methodologies. Some energy shares cannot be calculated with the simple approach in detail and therefore cannot be considered in the appropriate way.
It also shows, that the introduction of the reference building method for the energy certificate was necessary, as the absolute numbers for the holistic approach does not show the energy efficiency of a building directly. Especially in terms of comparing two buildings, one must look also at the reference values.

REFERENCES

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