Calculation of the energy performance of ventilation and cooling systems

In the present paper, an update is given on the calculation related standards from CEN TC 156 in the area of ventilation and cooling, the EN 16798-family. The main changes in comparison with the public enquiry versions are described.

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The purpose of this short article is to give an update on the set of EPB standards on the calculation of ventilation and cooling systems, described in [1]. The changes made on the EN 16798 family from CEN TC 156 "Ventilation for buildings" since the public enquiry process are summarized.

General changes, made on all standards, concern the Annex A/Annex B approach for the referencing of the EPB standards, to provide the step by step implementation of the standards in the EU member states, plus different other adjustments according to the revised template given by the collective of team leaders (CTL).

Ventilation standards

In the module M5-5 "emission" standard EN 16798-7 (the former EN 15242), two major technical changes had to be made:

- the calculation of heating/cooling emission losses due to non-ideal control in case of air based heating and/or cooling, taking the temperature correction as an input from the module 3-5/4-5 heating/cooling emission standard (EN 15316-2);
- the description of the control dependent air flow rate calculation in case of demand controlled ventilation had to be taken out of the normative part and was moved to the Annexes A and B.

In the detailed method 1 of "distribution" and "generation" EN 16798-5-1, the changes are:

- The calculation method for the heat and moisture recovery behavior of rotary heat exchangers was eliminated from the normative part. Instead, a generic function for the description was introduced, to be defined on a national basis. This reduced considerably the need for input data. The method was, however, saved in an informative annex, including the default input data which had been in the Annex B before. This annex is referenced as a default function in Annex B. This method is an important contribution which goes beyond what many commercial simulation programs offer in this area, and can be used by referring to Annex D in EN 16798-5-1.

- The fan energy calculation, the background of which is described in detail in [2], contained implicitly a – rather theoretical - fan characteristic. This was eliminated and replaced by a generic function for the fan characteristic, giving the relation between the pressure difference and the volume flow rate. The principle of the calculation, however, with the different control options, was not influenced by this measure.

In method 2, EN 16798-5-2, the calculations of humidification were eliminated. Both standards have one common technical report, CEN/TR 16798-6.

Cooling calculation standards

General

The most extensive changes were applied to the "general" part, EN 16798-9. As this standard connects the calculation pieces of the other standards for emission, distribution, storage and generation to a complete system (as explained in [1]), covering the possible setups and aspects of a hydronic system, the method was in its general application rather complicated. Some simplification possibilities had been provided, e.g. for direct expansion (DX) systems, where the whole hydronic calculation can be skipped. But this was done in some sub clauses within the same method.

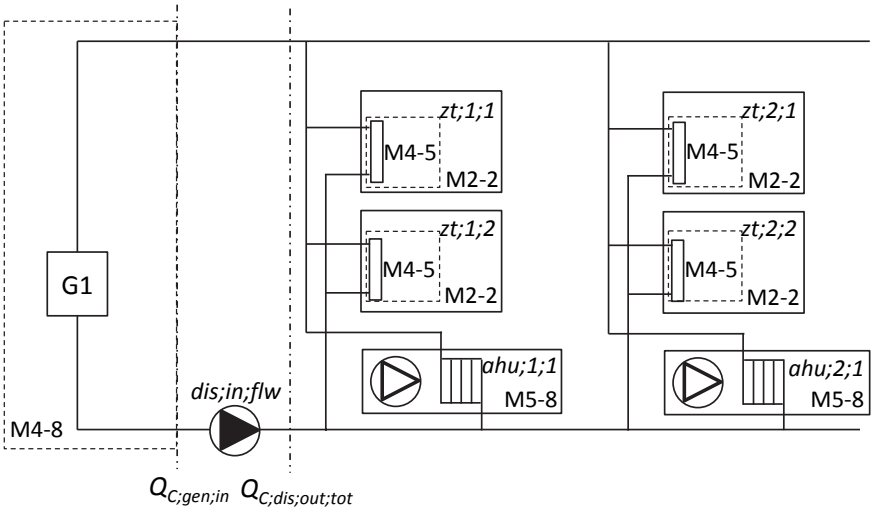

Figure 1. Hydronic cooling system scheme with module boundaries and nomenclature as given in CEN/TR 16798-10 for the simplified method.

In the revised version, a completely separate new simplified method has been added. This is not only supposed to be used for DX systems, but also for hydronic systems where the details of the system setup are not known or the effort to collect all the date needed would take inappropriate time. This new simplified method does not include the detailed calculation of the distribution losses and auxiliary energy provided by EN 15316-3, but uses a simple factor based approach for the estimation of these issues. Due to this, it is not possible to consider the special effects of a hierarchical network as with the detailed method. The simplified scheme is shown in **Figure 1**. It also does not include any storage calculation.

For DX systems, the distinction is made between zone based emitters and an air based distribution. The schemes are shown in **Figure 2**. It can be seen that the number of involved modules is very small. What remains in all cases are the emission parts, in order to keep the non-ideal control losses.

This new simplified method reduces dramatically the need of input data. To make this transparent was the main reason why the method has been added. Also, it can easily be applied for longer calculation intervals like monthly calculations.

In the accompanying technical report CEN/TR 16798-10, examples are given for the simplified and detailed calculation methods, where the spreadsheets are provided for. This includes also an example with

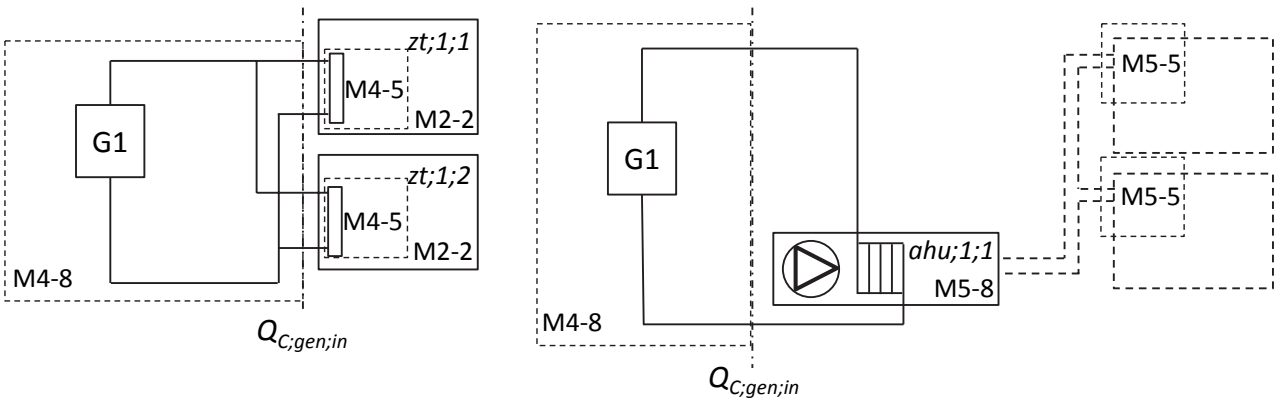

Figure 2. DX cooling system schemes for zone based emitters (left) and air based distribution (right) as given in CEN/TR 16798-10 for the simplified method.

a whole set of linked spreadsheets for the setup [1]. According to the number of zones, AHUs and distribution branches, there are multiple instances of several of the spreadsheets. With this setup, the functionality of the whole set of calculations in the cooing area can be demonstrated.

The partial performance indicators as given in the equations (1) and (2) of [1] have been modified with additional factors in order to include an optional weighting of thermal and electrical energies.

Generation

In method 1 of the cooling generation calculation standard EN 16798-13, flexibility was added to the calculation of the EER. The calculation based on the EN 14825 SEER base values has been kept but modified to better comply to EN 14825 and to avoid the necessity to have a 5th measuring point (which is still of advantage, but can be replaced by a default assumption). In addition to this, the method has been extended to include the case relying only on the nominal EER according to EN 14511, or, if even this is missing, a default nominal EER value. The approach for this case is a constant energetic efficiency. This was needed because it is not mandatory for the suppliers to provide the EN 14825 based SEER and the related EER values before 2018, and therefore it cannot be expected to get these values in all cases.

Method 2 was not principally changed, but improved based on the spreadsheet experiences.

No principle changes needed to be done on the cooling storage standard EN 16798-15.

Conclusion

With these modifications, a consistent set of calculation standards in the ventilation and cooling area will be provided. ■

Literature

[1] Gerhard Zweifel: Calculation of the energy performance of ventilation and cooling systems; REHVA Journal, 01-15, January 2015, p 31 ff.

[2] Jürg Tödtli: The impact of control on the energy use of fans in building ventilation systems; REHVA Journal 05-15, October 2015, p 50 ff.

Referred standard titles:

EN 16798-7:2016 Energy performance of buildings — Module M5-5 — Ventilation for buildings— Calculation methods for energy requirements of ventilation and air conditioning systems — Part 7: Emission (determination of air flow rates, revision of EN 15242).

EN 15316-2:2016 Energy performance of buildings, modules M3-5, M4-5 – Space emission systems (heating and cooling).

EN 16798-5-1:2016 Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 5-1: Distribution and generation (revision of EN 15241) — method 1.

CEN/TR 16798-6:2016 Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 6: Technical report - interpretation of the requirements in EN 16798-5-1 and EN 16798-5-2.

EN 15316-3:2016 Energy performance of buildings, Modules M3-6, M4-6, M8-6 – Space distribution systems (DHW, heating and cooling).

CEN/TR 16798-10:2016 Technical report to energy performance of buildings — Modules M4-1, M4-4, M4-9 - Ventilation for buildings - methods for the calculation of the energy performance of cooling systems — Part 10: General - Technical report - interpretation of the requirements in EN 16798-9.

EN 16798-13:2016 Energy performance of buildings — Module M4-8 - Ventilation for buildings - methods for the calculation of the energy performance of cooling systems — Part 13: Generation

EN 16798-15:2016 Energy performance of buildings — Module M4-7 — Ventilation for buildings — Calculation of cooling systems — Part 15: Storage.

EN 14825:2016 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance.

EN 14511-family (2013) Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling.