The new EN 15316-2*
– a standard for calculating the additional energy use of emission systems

* In this draft standard and this article we still use the terminology "emission" in the future version of the EPB standards we will replace the word "emission" by "emitter". This will be done to avoid the negative connotation of word "emission" which is mainly used in the context of pollutants.

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The European Commission asked CEN (mandate M480) to develop standards supporting the application of recast EPBD in the Member States.

This standard constitutes the specific part related to space heating and cooling emission. It specifies the structure for calculating the additional energy use of an emission system.

The new standard supersedes EN 15316-2-1:2007.The main changes compared to EN 15316-2-1:2007 are:

- the two calculation methods have been removed from the standard. Now only one calculation method is in the standard;
- the standard covers also cooling emission systems;
- the standard was updated to cover hourly and monthly time-step.

In the present paper, a short introduction of the new calculation approach of prEN 15316-2 is given.

This new standard has been prepared by Technical Committee CEN/TC 228 "*Heating systems and water based cooling systems in buildings*". It is part of a package developed to support the Energy Performance of Buildings Directive (EPBD) implementation.

The actual European standard EN 15316-2.1 [1] from 2007 includes two methods for the calculation of the additional energy use for heat emission systems [2, 3]. The new standard draft prEN 15316-2 (as expected to go out for Formal Vote by the end of 2015) provides only one calculation method. In addition, the new prEN15316-2 determines also the additional energy use of water based cooling emission systems. A fundamental point is that the calculation procedure should also be based on tested and certified product values.

Calculation principles

The influences of various phenomena are taken into account in prEN 15316-2 for the calculation of the additional energy use due to often called emission losses. Although these are sometimes not real losses but additional energy use, it is a convention to speak of emission losses. Some come from the physics:

- Embedded emission in the building structure (e.g. floor heating);
- Radiation (e.g. meaning air temperature can be lowered due to radiation effects);
- The stratification (higher air temperatures in the near of the ceiling for convective dominated systems);
- Intermittency.

Some others also based on physics and are additionally influenced by the behavior of the user related to the quality of:

- The building automation and control;
- The hydraulic balance;
- The building management systems (BMS).

It is observed that if the quality of control is low, the user will compensate by increasing the set point temperature in order to obtain the desired comfort. This is modeled by acting on the set point temperature.

prEN 15316-2 proposes to represent all the phenomena by the temperature difference in order to get a unique performance indicator for the classification of the products.

The temperature variation based on all influencing factors can be calculated with Equation (1). For some cases (e.g. for $\theta_{room\ aut}$) also negative values of the temperature variations are possible.

$$\Delta\theta_{int;inc} = \Delta\theta_{str} + \Delta\theta_{ctr} + \Delta\theta_{emb} + \Delta\theta_{rad} + \Delta\theta_{im} + \Delta\theta_{hydr} + \Delta\theta_{room\ aut} \quad (1)$$

With:

$\Delta\theta_{str}$ = spatial variation of temperature due to stratification (K);

$\Delta\theta_{ctr}$ = temperature variation based on control variation (K);

$\Delta\theta_{emb}$ = temperature variation based on an additional heat loss of embedded emitters (K);

$\Delta\theta_{rad}$ = temperature variation based on radiation by type of the emission system (K);

$\Delta\theta_{im}$ = temperature variation based on intermittent operation and based on the type of the emission system (K);

$\Delta\theta_{hydr}$ = temperature variation based on not balanced hydraulic systems (K);

$\Delta\theta_{room\ aut}$ = temperature variation based on stand alone or networked operation room automatization of the system (K)

The calculation of the thermal input for the cooling/heating emission system can be performed on a monthly or on an hourly basis.

Depending on the calculation interval two possibilities are given to calculate the emission sub-system:

- The emission loss approach for a monthly method. The energy needs are calculated with the initial set point temperature according to EN/ISO 13790. The energy needs are then increased by the emission losses (see Equation (2));
- The holistic approach for an hourly method. The energy needs are calculated with the initial set point temperature plus the temperature increase due to the characteristics of the emission sub-system (the emission losses are taken into account directly in the energy need calculation).

In the monthly method the emission losses are calculated as follows (Equation 2). Equation 2 does not apply if there is no thermal output of the emission system (e.g. in the heating case, if the external temperature is equal or higher than the internal temperature).

$$Q_{em;ls} = Q_{em;out} \cdot \left(\frac{\Delta\theta_{int;inc}}{\theta_{int;inc} - \theta_{e;comb}} \right) \quad (2)$$

with

$\Delta\theta_{int;inc}$ = temperature variation based on all influencing factors (K);

$\theta_{int;inc}$ = initial internal temperature (operative temperature) (°C);

$\theta_{e;comb}$ = fictive external temperature during the calculation period (°C);

$Q_{em;ls}$ = additional energy use (heat / cooling losses) of emission (kWh);

$Q_{em;out}$ = thermal output of the heat emission system (kWh)

For heating systems $\theta_{e;comb}$ is the average external temperature during the calculation period.

For cooling systems the fictive external temperature is corrected in the following way:

$$\theta_{e;comb} = \theta_{e;avg} + \Delta\theta_{e;sol} \quad (3)$$

The temperature difference $\Delta\theta_{e;sol}$ represents additional heat gains (e.g. solar heat gains). Default values of $\Delta\theta_{e;sol}$ are tabulated in prEN15316-2.

In the hourly calculation method the user behavior related to the set point temperature can be represented as such. In this case, the additional losses are determined by the simplified hourly energy needs calculation in EN ISO 13790 with the corresponding modified set point temperature.

Input data

Default values for the temperature variations are given in the annexes of the prEN15316-2. For the controller **Table 1** shows the relevant values.

These values could be used if only the product group is known (e.g. during the first design of a HVAC – system). If the products are known and certified then the certified values should be used.

For controllers the temperature variation $\Delta\theta_{ctr}$ is the CA-value (Control accuracy) from EN15500 [5].

For thermostatic valves $\Delta\theta_{ctr}$ -values are from EN215 [6] with is under revision now. The link to the product standard EN215 is in the normative part of the standard. In the informative Annex of the prEN 15316-2 a calculation equation for the CA-values is given as follows:

$$\Delta\theta_{ctr} = \text{CA-value} = 0.45\cdot(\theta_W + \theta_H) \qquad (4)$$

With
θ_W = water temperature influence of the controller
θ_H = hysteresis

This equation can be used during the revision period of the EN 215 and when no other calculation formula is available. It should be noted that the CA-value according EN 15500 and the CA-value calculated on products values based on EN 215 [6] are not completely comparable because of different test procedures. It would be useful to develop a generally applicable test procedure for controllers and thermostatic valves. An additional point is that the Equation (4) is a well-used formula in France but without any scientific background. Therefore, many investigations were carried out in the early past to the topic of CA-value s for TRV systems. In [7] results are presented which are shows that many parameters have an influence on the thermal behavior of TRV-Systems. Especially the

- water temperature influence,
- hysteresis,
- proportional band,
- size of the radiator,
- valve authority,
- supply temperature,
- differential pressure,
- and the flow field around the TRV.

Not all the parameters were investigated very well in the past. But the investigations in [7] can by a starting point of a new discussion. **Figure 1** and **2** show some results.

The printed out curves shows the that the CA-value equation in the present EN 15316-2 represent only in the case of a supply temperature based on the external temperature the behavior of TRV approximately. In the special case of constant supply temperature, the equation fails. Therefore additional investigations are needed.

The same comment applies to the heat and cooling emission system itself. The product standards EN 1264 [8] for embedded heating and cooling systems and the EN 442 [9] for radiator systems do not provide infor-

Table 1. Default values for temperature variation on control.

Product group	$\Delta\theta_{ctr;1}$
Unregulated, with central supply temperature regulation	2.5
Master room space or one-pipe heating	2
Room temperature control (electromechanical / electronic)	1.8
P-controller (before 1988)	1.4
P-controller	1.2
PI-controller	1.2
PI-controller (with optimisation function, e.g. presence management, adaptive controller)	0.9

Note:
P controller (proportional controller)- typically thermostatic controlled valves (TRV)
PI- controller (proportional integral controller)– typically electronic controller

P-controllers are usually directly placed on the emitter (e.g. radiator), PI-controller and "room temperature controlled" in accordance to table 1 can also be installed on a surrounding wall of the room.

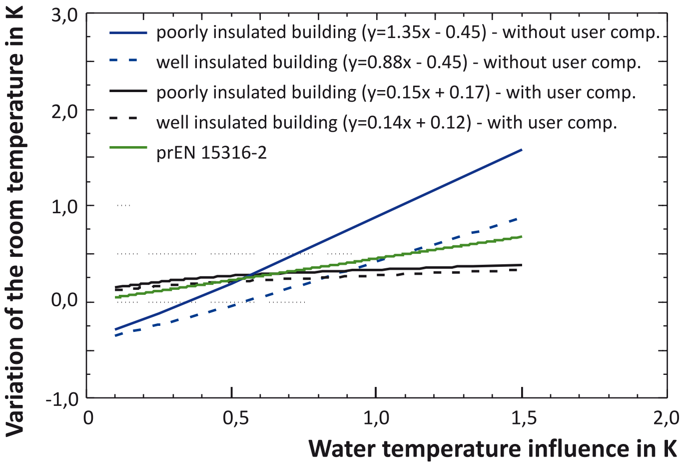

Figure 1. Variation of the room temperature based on the water temperature influence [7] (supply temperature depend on the external temperature).

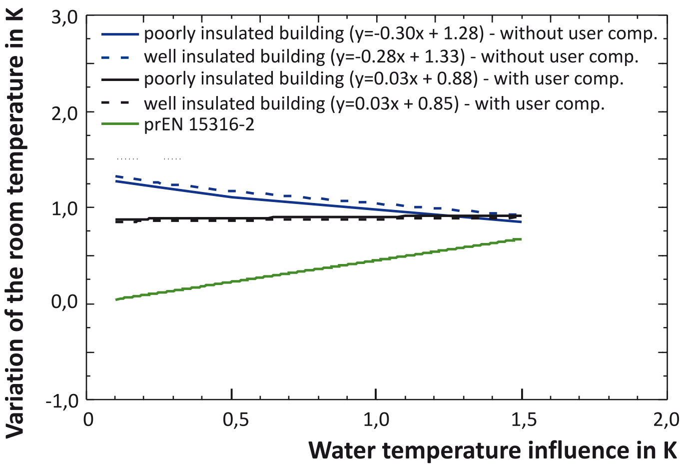

Figure 2. Variation of the room temperature based on the water temperature influence [7] (constant supply temperature).

mation about energy relevant values to be directly used in the calculation method of prEN 15316-2 (temperature variation $\Delta\theta_{rad}$ and $\Delta\theta_{im}$).

prEN 15316-2 has a strong link to the building automation standards (TC247). Work is still needed to harmonize the default product groups in **Table 1** with the classification of the controllers in relation to EN 15232 [10] (e.g. EN 15232 BACS functions, identifiers). It is important for the European industry that there is a common and continuous chain of product testing and standardization, certification, building regulation.

Conclusions

prEN 15316-2 is now under public enquiry until march 2015. prEN 15316-2 is a further step for the harmonization of the energy calculation of buildings. Compared to the existing EN 15316-2.1 there is now only one calculation method in the standard. The method is based on temperature differences. Also cooling emission systems are taken into account in the new standard.

The new prEN 15316-2 has a strong link with product testing. Certified product values can be used directly in the standard. Conservative default values are provided in the annex of the standard.

It should be noticed, that not all the necessary values are already based on product testing. Thus the product standards should be revised in the near future. ■

References

[1] EN 15316-2.1: Method for calculation of system energy requirements and system efficiencies – Part 2-1: Space heating emission systems; 2007.

[2] DIN V 18599-T5: Energetische Bewertung von Gebäuden, Deutsches Institut für Normung e.V., Berlin, 2011.

[3] RT2012: Réglementation thermique, 2012.

[4] prEN 15316-2: Energy performance of buildings - Space emission systems (heating and cooling), 2014.

[5] EN 15500: Control for heating, ventilating and air-conditioning applications - Electronic individual zone control equipment.

[6] EN 215: Thermostatic radiator valves - Requirements and test methods, 2006.

[7] Seifert, J.; Knorr, M.; Schinke, L.; Bitter, F.: Bewertung thermostatischer Regelventile im Rahmen der europäischen Systemnormung, Moderne Gebäudetechnik, 5/2015.

[8] EN 1264: Water based surface embedded heating and cooling systems – Part 2: Floor heating: Prove methods for the determination of the thermal output using calculation and test methods, 2013.

[9] EN 442: Radiators and convectors - Part 2: Test methods and rating, 2013.

[10] EN 15232: Energy performance of buildings - Impact of Building Automation, Controls and Building Management, 2012.