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Information paper on EN 15316-3-2

Domestic Hot Water systems - Distribution

This paper gives a short introduction to the CEN standard for calculation of the losses from domestic hot water distribution systems. It contains explanations of the calculation methods with details on the input and output data and the links with other CEN standards. Distribution losses may be 25% or more of total DHW energy needs for distribution pipes of 10 m and more and for large, badly insulated circulation systems.

1 > Scope of the standard

The standard gives methods for calculation of heat losses, the recoverable heat losses and the auxiliary energy of the domestic hot water distribution system. The standard is the second part of a series of three standards for calculation of domestic hot water system energy requirements and system efficiencies (see figure 1). The other standards treat DHW needs (EN 15316-3-1) and generation systems (EN 15316-3-3).

2 > Principle of the methods

Domestic hot water distribution systems may consist of a circulation system and/or distribution pipes (see figure 2).
Distribution pipe losses are dominated by the heating up and cooling down of the pipes at any tapping, so these losses are sensitive to the tapping pattern. The standard gives five calculation methods for distribution pipe losses:

- Heat losses related to floor area
- Heat losses related to pipe lengths – simple method
- Heat losses related to pipe lengths – tabulated data method
- Heat losses related to tapping pattern
- Heat losses based on detailed calculation method

Circulation systems are in general operated at constant temperature. Therefore circulation system losses do not depend on tapping patterns. Loss reduction may be achieved by applying pipe insulation and night set-back. The standard gives the following methods to calculate circulation system losses:

- Heat losses related to circulation pipe length
- Heat losses based on detailed calculation method
- Heat losses while circulation is off

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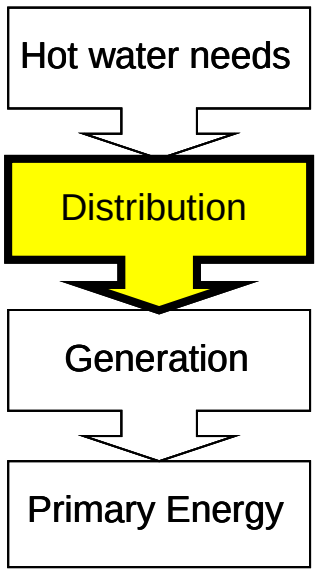

Figure 1: The calculation of the distribution losses / efficiency is the second step in the DHW Energy calculation

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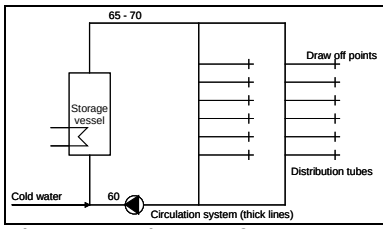

Figure 2: Scheme of a DHW circulation system with two branches and short distribution pipes to the tapping points.
This type of system is frequently applied in hotels, hospitals and blocks of flats.

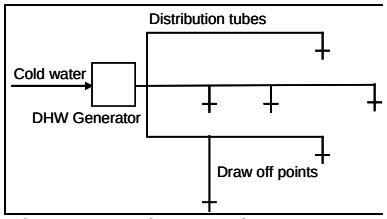

Figure 3: Scheme of a DHW system with only distribution pipes. This type of installation is dominant in single family dwellings.

The total heat losses are the sum of distribution pipe losses (no circulation loop) and circulation system losses (collective part with circulation loop).

Also methods are given to determine auxiliary energy consumption for:
- pumps for circulation systems.
- ribbon or trace heating

To determine distribution losses in dwellings, a detailed tapping pattern is needed. In many single family dwellings, the distribution system consists of distribution pipes of 10 or more meters length without a circulation loop, causing significant start/stop losses (see figure 3). These distribution losses may be in the same order of magnitude as the heat demand.
The methods are summarized below. For all methods a national annex is required. The annexes to the standard provide default values. Required inputs depend on the methods and are also given below.
The resulting outputs are the heat losses in MJ/day or MJ/year.

3 > Distribution pipe losses (without a circulation loop)

Heat losses related to floor area

This method is defined in clause 6.2.2 of EN 15316-3-2. It is a simplified method relating the distribution pipe heat losses only to building floor area. Thus, detailed knowledge of the domestic hot water distribution system is not required. This method can only be applied in a limited number of situations and is usually restricted to domestic buildings with a domestic hot water distribution system that does not involve a circulation loop. If this method is applicable, details for the calculation and the limitations in its use are to be given in a National Annex. Although a detailed knowledge of the domestic hot water distribution system is not required, the pipe lengths should be kept to a minimum. The maximum acceptable distribution pipe length for this method may be given in a National Annex.

Heat losses related to pipe lengths - simple method

This method is defined in clause 6.2.3 and worked out in annex A of EN 15316-3-2. This calculation method takes into account the heat losses due to the full cooling down of the pipe and the water within it after any tapping. It is also possible to include the heat losses from the user outlets in this method.

Details of this method are to be given in a National Annex. A reduction of heat losses in the case of short intervals between the tapping cycles is not taken into account in this calculation method. In such a case the effect of pipe insulation on heat losses must be taken into account. If this is to be considered, details are to be given in a National Annex.
The input parameters for every pipe section are:
- pipe length in m;
- pipe inner and outer diameter in m;
- specific mass and heat capacity of water and pipe material;
- nominal hot water temperature in °C;
- average ambient temperature in °C;
- number of tappings per day for this pipe section.

Heat losses related to pipe lengths - tabulated data method

This method is defined in clause 6.2.4 of EN 15316-3-2. It is based on estimates of the proportion of the heat energy reaching the user outlets for different pipe lengths and diameters. A distinction is made between supplies to kitchens and to bathrooms.

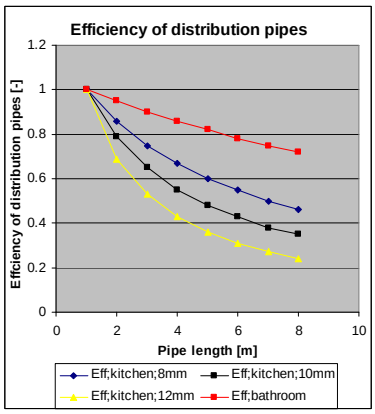

Figure 4: Example of the proportion of useful heat, reaching user outlets (Annex B – tabulated data method) The low efficiencies for the kitchen are the result of the relative small heat demand per tapping. In the bathroom, relative large heat demands per tapping are required.

Detailed knowledge of the domestic hot water distribution system is not required; only the hot water demand rates of kitchen and bathroom are required. If this method is applicable, details for the calculation and suitable tabulated values are to be given in a National Annex. A table of default values is given in Annex B (see figure 4).
The input parameters are:

- pipe length to kitchen and bathroom in m;
- pipe inner diameter to kitchen in m.

Heat losses related to tapping pattern

This method is defined in clause 6.2.5 of EN 15316-3-2. It is based on estimates of the heat losses expressed as a proportion of the domestic hot water energy demand at the user outlet device. The calculation method is described in Annex C. Details of this method, including the equivalent energy loss factors, are to be given in a National Annex.
The input parameters are:

- hot water energy need;
- pipe length in m;
- position of pipes (inside or outside the building)

Heat losses based on detailed calculation method

This method is described in clause 6.2.6 of EN 15316-3-2. It is based on the calculation of the pipe heat loss, assuming an average temperature of the pipe section (part of the distribution system, e.g. section serving the kitchen). The calculation method is worked out in Annex D. Details of this method are to be given in a National Annex.
The input parameters for every pipe section are:

- pipe length in m;
- linear thermal transmission coefficient in W/(m·K);
- average temperature of pipe section in °C;
- average ambient temperature in °C;
- daily utilization period at the corresponding temperature in h/day.

For this method the determination of the average temperature of a pipe section is crucial. It depends on the number of tappings, nominal hot water temperature, ambient temperature and the transmission coefficient. Thus, a full dynamic calculation (not described in the standard or annex), depending on these parameters, is required to obtain the average temperature. But when performing this full dynamic calculation, the heat loss of the pipe is already calculated.

As an alternative a simplified version “Heat losses related to pipe lengths – simple method” is given.

4 > Circulation pipe losses

Heat losses related to circulation pipe length

This method is defined in clause 6.3.2 of EN 15316-3-2. It can be applied if no exact design of the domestic hot water system is available or the pipe insulation thickness is not known. Values (heat losses per pipe length) should be given in a National Annex. A default value is given in Annex D.
The input parameter is:

- circulation pipe length in m.

Figure 5: Example of poor insulation of circulation tubes.

Heat losses based on detailed calculation method
This method is defined in clause 6.3.3 of EN 15316-3-2. It is applicable if exact design data of the domestic hot water system is available. Values (characteristic values for detailed calculation as ambient temperature or length of circulating loop) should be given in a National Annex. If a National Annex is not provided or does not include these data, default values are given in Annex D.
The input parameters are for every pipe section:

- circulation pipe length in m;
- linear thermal transmission coefficient in W/(m·K);
- average temperature of pipe section in °C;
- average ambient temperature in °C;
- daily utilization period at the corresponding temperature in h/day.

Heat losses while circulation is off

This method is defined in clause 6.3.4 of EN 15316-3-2. It assumes a complete cooling down of the system when circulation is off.
The input parameters are for every pipe section:

- circulation pipe volume in m^3;
- average temperature of pipe section in °C;
- average ambient temperature in °C;
- number of circulation pump operating cycles per day.

Heat emission due to accessories

This method is defined in clause 6.4 of EN 15316-3-2. The heat emission from the circulation loop is increased by the energy lost through fittings i.e. valves and flanges and also through pipe hangers.
These heat emission values are estimated by introducing an additional equivalent pipe length. If these losses are to be included in the analysis, details are to be given in a National Annex.

5 > FAQ

What's the relevance of DHW distribution losses in total DHW energy needs?
Distribution losses may be 25% or more of total DHW energy needs for distribution pipes of 10 m and more and for large, badly insulated circulation systems (see figure 5).

Why the standard contains so many different methods?
This reflects both different levels of detail and the different traditions in European countries on this subject.

Is a national annex required for this standard?
Yes it is. Countries need to decide which method(s) they prefer and need to add default values for some methods.
It is recommended to develop a calculation method for distribution systems for dwellings that requires few inputs. In addition a more sophisticated method may be given to allow detailed calculations if additional data are available.
For circulation systems the same approach may be followed, combining the simple method (pipe length only) and the detailed method.

Have the methods been validated?
The methods to determine circulation system losses are based on physics. Correctness is determined by the right assessment of heat loss coefficients and losses due to accessories.
The methods to determine distribution pipe losses have to deal with both the heating up and cooling down of the pipes, in relation to the dynamic profile of the temperature at the tap. Most methods do not deal with this in full detail.

6 > References

1. EN 15316-3-1 Domestic Hot Water Systems – Characterisation of needs (tapping requirements)
2. EN 15316-3-2 Domestic Hot Water Systems - Distribution
3. EN 15316-3-3 Domestic Hot Water Systems - Generation

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