SLOVENSKI STANDARD
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Ogrevalni sistemi v stavbah - Metoda za preraļ un energijskih zahtev in uļ inkovitosti sistema - 4-7. del: Proizvodnja toplote za ogrevanje prostorov, sistemi za zgorevanje biomase

Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-7: Space heating generation systems, biomass combustion systems

Heizanlagen in Gebäuden - Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen - Teil 4-7: Wärmeerzeugung für die Raumheizung, Biomassewärmeerzeuger

Systemes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et de l'efficacité des systemes - Partie 4-7 : Systeme de génération de chauffage des locaux, systemes de combustion de biomasse

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Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-7: Space heating generation systems, biomass combustion systems

Systèmes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 4-7 : Systèmes de génération de chauffage des locaux, systèmes de combustion de la biomasse

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This European Standard was approved by CEN on 30 September 2008.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

Foreword

This document (EN 15316-4-7:2008) has been prepared by Technical Committee CEN/TC 228 “Heating systems in buildings”, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2009, and conflicting national standards shall be withdrawn at the latest by May 2009.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/343), and supports essential requirements of EU Directive 2002/91/EC on the energy performance of buildings (EPBD). It forms part of a series of standards aimed at European harmonisation of the methodology for calculation of the energy performance of buildings. An overview of the whole set of standards is given in CEN/TR 15615.

The subjects covered by CEN/TC 228 are the following:

— design of heating systems (water based, electrical etc.);

— installation of heating systems;

— commissioning of heating systems;

— instructions for operation, maintenance and use of heating systems;

— methods for calculation of the design heat loss and heat loads;

— methods for calculation of the energy performance of heating systems.

Heating systems also include the effect of attached systems such as hot water production systems.

All these standards are systems standards, i.e. they are based on requirements addressed to the system as a whole and not dealing with requirements to the products within the system.

Where possible, reference is made to other European or International Standards, a.o. product standards. However, use of products complying with relevant product standards is no guarantee of compliance with the system requirements.

The requirements are mainly expressed as functional requirements, i.e. requirements dealing with the function of the system and not specifying shape, material, dimensions or the like.

The guidelines describe ways to meet the requirements, but other ways to fulfil the functional requirements might be used if fulfilment can be proved.

Heating systems differ among the member countries due to climate, traditions and national regulations. In some cases requirements are given as classes so national or individual needs may be accommodated.

In cases where the standards contradict with national regulations, the latter should be followed.

EN 15316 *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies* consists of the following parts:

Part 1: General

Part 2-1: Space heating emission systems

Part 2-3: Space heating distribution systems

Part 3-1: Domestic hot water systems, characterisation of needs (tapping requirements)

Part 3-2: Domestic hot water systems, distribution

Part 3-3: Domestic hot water systems, generation

Part 4-1: Space heating generation systems, combustion systems (boilers)

Part 4-2: Space heating generation systems, heat pump systems

Part 4-3: Heat generation systems, thermal solar systems

Part 4-4: Heat generation systems, building-integrated cogeneration systems

Part 4-5: Space heating generation systems, the performance and quality of district heating and large volume systems

Part 4-6: Heat generation systems, photovoltaic systems

Part 4-7: Space heating generation systems, biomass combustion systems

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard presents methods for calculation of the additional energy requirements of a heat generation system by biomass combustion in order to meet the distribution and/or storage sub-system demand. The calculation is based on the performance characteristics of the products given in product standards and on other characteristics required to evaluate the performance of the products as included in the system.

This method can be used for the following applications:

— judging compliance with regulations expressed in terms of energy targets;

— optimisation of the energy performance of a planned heat generation system, by applying the method to several possible options;

— assessing the effect of possible energy conservation measures on an existing heat generation system, by calculating the energy use with and without the energy conservation measures.

The user needs to refer to other European Standards or to national documents for input data and detailed calculation procedures not provided by this European Standard.

1 Scope

This European Standard is part of a series of standards on the method for calculation of system energy requirements and system efficiencies of space heating systems and domestic hot water systems.

The scope of this specific part is to standardise the:

— required inputs;

— calculation method;

— resulting outputs,

for space heating generation by biomass combustion sub-systems (boilers) with stocking by hand, including control.

This European Standard is also intended for the case of generation for both domestic hot water production and space heating. The case of generation only for domestic hot water production is treated in EN 15316-3-3.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 303-5, *Heating boilers — Part 5: Heating boilers for solid fuels, hand and automatically stocked, nominal heat output of up to 300 kW — Terminology, requirements, testing and marking*

EN ISO 7345:1995, *Thermal insulation — Physical quantities and definitions (ISO 7345:1987)*

EN 15316-2-3, *Heating systems in building — Method for calculation of system energy requirements and system efficiencies — Part 2-3: Space heating distribution systems*

EN 15316-3-2, *Heating systems in building — Method for calculation of system energy requirements and system efficiencies — Part 3-2: Domestic hot water systems, distribution*

EN 15316-3-3, *Heating systems in building — Method for calculation of system energy requirements and system efficiencies — Part 3-3: Domestic hot water systems, generation*

EN 15316-4-1:2005, *Heating systems in building — Method for calculation of system energy requirements and system efficiencies — Part 4-1: Space heating generation systems, combustion systems (boilers)*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345:1995 and the following apply.

3.1.1
space heating
process of heat supply for thermal comfort

3.1.2
domestic hot water heating
process of heat supply to raise the temperature of the cold water to the intended delivery temperature

3.1.3
heated space
room or enclosure which for the purposes of the calculation is assumed to be heated to a given set-point temperature or set-point temperatures

3.1.4
system thermal loss
thermal loss from a technical building system for heating, cooling, domestic hot water, humidification, dehumidification, ventilation or lighting that does not contribute to the useful output of the system

NOTE Thermal energy recovered directly in the subsystem is not considered as a system thermal loss but as heat recovery and is directly treated in the related system standard.

3.1.5
auxiliary energy
electrical energy used by technical building systems for heating, cooling, ventilation and/or domestic hot water to support energy transformation to satisfy energy needs

NOTE This includes energy for fans, pumps, electronics etc. Electrical energy input to the a ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation.

3.1.6
heat recovery
heat generated by a technical building system or linked to a building use (e.g. domestic hot water) which is utilised directly in the related system to lower the heat input and which would otherwise be wasted (e.g. preheating of the combustion air by flue gas heat exchanger)

3.1.7
total system thermal loss
total of the technical system thermal loss, including recoverable system thermal losses

3.1.8
recoverable system thermal loss
part of the system thermal loss which can be recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

3.1.9
recovered system thermal loss
part of the recoverable system thermal loss which has been recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

3.1.10
gross calorific value
quantity of heat released by a unit quantity of fuel, when it is burned completely with oxygen at a constant pressure equal to 101 320 Pa, and when the products of combustion are returned to ambient temperature

NOTE 1 This quantity includes the latent heat of condensation of any water vapour contained in the fuel and of the water vapour formed by the combustion of any hydrogen contained in the fuel.

NOTE 2 According to ISO 13602-2, the gross calorific value is preferred to the net calorific value.

NOTE 3 The net calorific value does not take into account the latent heat of condensation.

3.1.11
net calorific value
gross calorific value minus latent heat of condensation of the water vapour in the products of combustion at ambient temperature

3.1.12
calculation step
discrete time interval for the calculation of the energy needs and uses for heating, cooling, humidification and dehumidification

NOTE Typical discrete time intervals are one hour, one day, one month or one heating and/or cooling season, operating modes, and bins.

3.1.13
calculation period
period of time over which the calculation is performed

NOTE The calculation period can be divided into a number of calculation steps.

3.1.14
external temperature
temperature of external air

NOTE 1 For transmission heat transfer calculations, the radiant temperature of the external environment is supposed equal to the external air temperature; long-wave transmission to the sky is calculated separately.

NOTE 2 The measurement of external air temperature is defined in EN ISO 15927-1.

3.1.15
boiler
gas, liquid or solid fuelled appliance designed to provide hot water for space heating. It may (but need not) be designed to provide domestic hot water heating as well

3.1.16
combustion power
product of the fuel flow rate and the net calorific power of the fuel

3.1.17
condensing boiler
boiler designed to make use of the latent heat released by condensation of water vapour in the combustion flue products. The boiler needs to allow the condensate to leave the heat exchanger in liquid form by way of a condensate drain

NOTE Boilers not so designed, or without the means to remove the condensate in liquid form, are called 'non-condensing'.

3.1.18
modes of operation
various modes in which the heating system can operate (set-point mode, cut-off mode, reduced mode, set-back mode, boost mode)

3.1.19
modulating boiler
boiler with the capability to vary continuously (from a set minimum to a set maximum) the fuel burning rate whilst maintaining continuous burner firing

3.1.20
accumulator (storage) system
part of the generation system tank which stores excess heat during operation time (resulting from the difference between the boiler output and the actual heat input to the heating system)

3.1.21
load balancing (storage) system
part of the generation system tank which improves the operation conditions during operation time (resulting in reducing the starting intervals and increasing the running time of automatic fired biomass boilers (see EN 15316-4-1)

3.1.22
biomass boiler
biomass fuelled appliance designed to provide heating medium (e.g. water, fluid) for space heating

3.1.23
load factor
ratio between the time with the boiler ON and the total generator operation time

3.1.24
operation cycle
time period of the operation cycle of a boiler

3.2 Symbols and units

For the purposes of this document, the following symbols and units (Table 1) and indices (Table 2) apply.

Table 1 – Symbols and units

Symbol	Name of quantity	Unit
b	temperature reduction factor [c]	-
c	coefficient [c]	various
c	specific heat capacity	J/kg·K or Wh/kg·K [a]
E	energy in general (except quantity of heat, mechanical work and auxiliary (electrical) energy	J or Wh [a]
e	expenditure factor [c]	-
f	factor [c]	-
H	calorific value	J/mass unit or Wh/mass unit [b]
H	heat transfer coefficient [c]	W/K
k	factor [c]	-
m	mass	kg
n	exponent	-
N	number of items	integer
P	power in general including electrical power	W
Q	quantity of heat	J or Wh [a]
t	time, period of time	s or h [a]
V	volume	L
V'	volume flow	m³/s or m³/h [a]
W	auxiliary (electrical) energy, mechanical work	J or Wh [a]
α	loss factor	%
β	load factor	-
Δ	prefix for difference	
η	efficiency factor	%
θ	Celsius temperature	°C
Φ	heat flow rate, thermal power	W

[a] If seconds (s) is used as the unit of time, the unit for energy needs to be J; If hours (h) is used as the unit of time, the unit for energy needs to be Wh.
[b] Mass unit for fuel may be Stm³, Nm³ or kg.
[c] Coefficients have dimensions; factors are dimensionless.

Table 2 – Indices

acc	accumulator	gen	generation subsystem	on	on
aux	auxiliary	gnr	generator	op	operation
avg	average	grs	gross	out	output from subsystem
brm	boiler room	H	heating	P0	at zero load
cham	chamber	hup	heating up	Pint	at intermediate load
ch	chimney	i, j, k	indices	Pn	at nominal load
ci	calculation step	in	input to subsystem	Px	at x load
cmb	combustion	ins	insulation	rbl	recoverable
cod	cooling down	int	intermediate	ref	reference
cor	corrected / correction	lob	load balancing	rvd	recovered
ctr	control	ls	losses	s	gross (calorific value)
dis	distribution	m	mean	sby	in stand-by operation
em	emission	max	maximum	ta	tank
fa	factor	mass	massic	test	test conditions
fib	fire bed	min	minimum	W	heating system water
fg	flue gas	net	net	w	water
ge	generator envelope	off	off	z	indices

The indices specifying symbols for sub-system energy balance quantities are in the following order:

— the first index represents the use (H = space heating, W = domestic hot water etc.);

— the second index represents the sub-system (gen = generation, dis = distribution etc.);

— the third index represents the balance item (ls= losses, in = input, aux = auxiliary etc.).

Other indices may follow for more details (rvd = recovered, rbl = recoverable etc.).

4 Principle of the method

4.1 Heat balance of the biomass combustion sub-system, including control of heat generation

4.1.1 Physical factors for biomass combustion sub-system (biomass boiler) taken into account

The calculation method of the boiler takes into account heat losses and/or recovery due to the following physical factors:

— heat losses to the chimney (or flue gas exhaust) during total time of boiler operation (running and stand-by);

— heat losses through the boiler envelope during total time of boiler operation (running and stand-by);

— auxiliary energy.

The relevance of these effects on the energy requirements depends on:

— type of the boiler;

— location of the boiler;

— part load ratio;

— operating conditions (temperature, control etc.);

— control strategy (on/off, modulating).

4.1.2 Calculation structure (input and output data)

The calculation method of this European Standard shall be based on the following:

— heat demand of the distribution sub-system(s) for space heating, $\Sigma Q_{H,dis,in}$, calculated according to EN 15316-2-3;

— heat demand of the distribution sub-system(s) for domestic hot water, $\Sigma Q_{W,dis,in}$, calculated according to EN 15316-3-2, where appropriate.

The performance of the boiler may be characterised by additional input data to take into account:

— type and characteristics of the boiler;

— boiler settings;

— type of the boiler control system;

— location of the boiler;

— operating conditions;

— heat requirement.

Based on these data, the following output data are determined by calculations according to this European Standard:

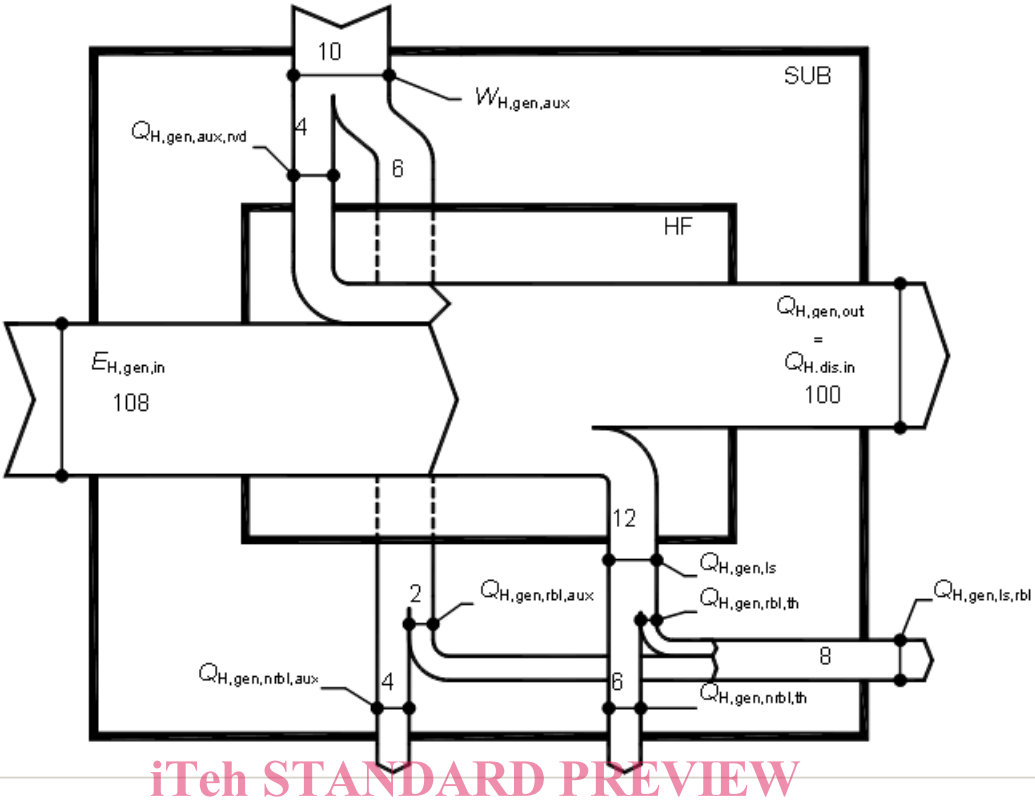
— fuel heat requirement, $E_{H,gen,in}$;

— total generation thermal losses (flue gas and boiler envelope), $Q_{H,gen,ls}$;

— recoverable generation thermal losses, $Q_{H,gen,ls,rbl}$;

— generation auxiliary energy, $W_{H,gen,aux}$.

Figure 1 shows the calculation inputs and outputs of the generation sub-system.



Key

SUB	generation sub-system balance boundary
HF	heating fluid balance boundary (see Equation (1))
$Q_{H,gen,out}$	generation sub-system heat output (input to distribution subsystem(s))
$E_{H,gen,in}$	generation sub-system fuel input (energyware)
$W_{H,gen,aux}$	generation sub-system total auxiliary energy
$Q_{H,gen,aux,rvd}$	generation sub-system recovered auxiliary energy
$Q_{H,gen,ls}$	generation sub-system total thermal losses
$Q_{H,gen,ls,rbl}$	generation sub-system thermal losses recoverable for space heating
$Q_{H,gen,rbl,th}$	generation sub-system thermal loss (thermal part) recoverable for space heating
$Q_{H,gen,rbl,aux}$	generation sub-system recoverable auxiliary energy
$Q_{H,gen,nrbl,th}$	generation sub-system thermal loss (thermal part) non recoverable
$Q_{H,gen,nrbl,aux}$	generation sub-system non recoverable auxiliary energy

NOTE Figures shown are sample percentages.

Figure 1 — General generation sub-system inputs, outputs and energy balance

4.2 Generation sub-system basic energy balance

The basic energy balance of the generation sub-system is given by:

$$E_{H,gen,in} = Q_{H,gen,out} - Q_{H,gen,aux,rvd} + Q_{H,gen,ls} \quad (1)$$

where

$E_{H,gen,in}$ heat requirement of the generation sub-system (fuel input);

$Q_{H,gen,out}$ heat supplied to the distribution sub-systems (space heating);