SLOVENSKI STANDARD
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Ogrevalni sistemi v stavbah - Metoda za preraļ un energijskih zahtev in uļ inkovitosti sistema - 4-2. del: Sistemi za ogrevanje prostora, toplotni ļ rpalni sistemi

Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-2: Space heating generation systems, heat pump systems

Heizsysteme in Gebäuden - Verfahren zur Berechnung des Energiebedarfs und der Nutzungsgrade der Systeme - Teil 4-2: Wärmeerzeugung für die Raumheizung, Wärmepumpensysteme

Systemes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et d'efficacité des systemes - Partie 2-2-2 - Systemes de génération de chauffage des locaux - Systemes de pompes a chaleur

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Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-2: Space heating generation systems, heat pump systems

Systèmes de chauffage dans les bâtiments - Méthode de calcul des besoins énergétiques et des rendements des systèmes - Partie 4-2 : Systèmes de génération de chauffage des locaux, systèmes de pompes à chaleur

Heizungsanlagen in Gebäuden - Verfahren zur Berechnung der Energieanforderungen und Nutzungsgrade der Anlagen - Teil 4-2: Wärmeerzeugung für die Raumheizung, Wärmepumpensysteme

This European Standard was approved by CEN on 15 May 2008.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 15316-4-2:2008) 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of an identical text or by endorsement, at the latest by December 2008, and conflicting national standards shall be withdrawn at the latest by December 2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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 [13].

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 is part of a series of standards on the methods for calculation of system energy requirements and system efficiencies. The framework for the calculation is described in the general part (EN 15316-1 [9]).

The energy performance can be assessed by determining either the heat generation sub-system efficiencies or the heat generation sub-system losses due to the system configuration.

This European Standard presents methods for calculation of the additional energy requirements of a heat generation sub-system in order to meet the distribution 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. Product data, e.g. heating capacity or *COP* of the heat pump, shall be determined according to European test methods. If no European methods exist, national methods can be used.

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 sub-system, by applying the method to several possible options;

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

Only the calculation method is normative. The user shall refer to other European Standards or to national documents for input data. Additional values necessary to complete the calculations are to be given in a national annex, if no national annex is available, default values are given in an informative annex where appropriate.

1 Scope

This European Standard covers heat pumps for space heating, heat pump water heaters (HPWH) and heat pumps with combined space heating and domestic hot water production in alternate or simultaneous operation, where the same heat pump delivers the heat to cover the space heating and domestic hot water heat requirement.

The scope of this part is to standardise the:

— required inputs,

— calculation methods,

— resulting outputs,

for heat generation by the following heat pump systems, including control, for space heating and domestic hot water production:

— electrically-driven vapour compression cycle (VCC) heat pumps,

— combustion engine-driven vapour compression cycle heat pumps,

— thermally-driven vapour absorption cycle (VAC) heat pumps,

using combinations of heat source and heat distribution as listed in Table 1.

Table 1 — Heat sources and heat distribution in the scope of this European Standard

Heat source	Heat distribution
Outdoor air	Air
Exhaust-air	Water
Indirect ground source with brine distribution	Direct condensation of the refrigerant in the appliance (VRF)
Indirect ground source with water distribution	
Direct ground source (Direct expansion (DX))	
Surface water	
Ground water	

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 255-3:1997, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors — Heating mode — Part 3: Testing and requirements for marking for sanitary hot water units*

EN 308, *Heat exchangers — Test procedures for establishing performance of air to air and flue gases heat recovery devices*

EN 14511:2007 (all parts), *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling*

CEN/TS 14825:2003, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Testing and rating at part load conditions*

prEN 15203, *Energy performance of buildings — Application of calculation of energy use to existing buildings*

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

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

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

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

EN ISO 13790 *Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790:2008)*

EN ISO 15927-6, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 6: Accumulated temperature differences (degree-days) (ISO 15927-6:2007)*

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
alternate operation
production of heat energy for the space heating and domestic hot water system by a heat generator with double service by switching the heat generator either to the domestic hot water operation or the space heating operation

3.1.2
application rating conditions
mandatory rated conditions within the operating range of the unit that are published by the manufacturer or supplier

3.1.3
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 1 This includes energy for fans, pumps, electronics, etc. Electrical energy input to the ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy use for ventilation.

NOTE 2 In EN ISO 9488 [15], the energy used for pumps and valves is called "parasitic energy".

NOTE 3 In the frame of this standard, the driving energy input for electrically-driven heat pumps in the system boundary of the *COP* according to EN 14511 and an electrical back-up heater is not entitled auxiliary energy but only additional electrical input not considered in the *COP*.

3.1.4
balance point temperature
temperature at which the heat pump heating capacity and the building heat load are equal

3.1.5
bin
statistical temperature class (sometimes a class interval) for the outdoor air temperature, with the class limits expressed in a temperature unit

3.1.6
building services
services provided by technical building systems and by appliances to provide indoor climate conditions, domestic hot water, illumination levels and other services related to the use of the building

3.1.7
calculation period
period of time over which the calculation is performed

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

3.1.8
calculation step
discrete time interval for the calculation of the energy needs and uses for heating, cooling, humidification and dehumidification

NOTE 1 Typical discrete time intervals are one hour, one month or one heating and/or cooling season, operating modes, and bins.

NOTE 2 In the frame of the bin method, calculation steps are based on outdoor temperature classes.

3.1.9
coefficient of performance *COP*
ratio of the heating capacity to the effective power input of the unit

3.1.10
cumulative frequency
frequency of the outdoor air temperature cumulated over all 1 K bins

3.1.11
cut-out period
time period in which the electricity supply to the heat pump is interrupted by the supplying utility

3.1.12
domestic hot water heating
process of heat supply to raise the temperature of the cold water to the intended delivery temperature

3.1.13
effective power input
average power input of the unit within the defined interval of time obtained from:

— the power input for operation of the compressor or burner and any power input for defrosting;

— the power input for all control and safety devices of the unit;

— the proportional power input of the conveying devices (e.g. fans, pumps) for ensuring the transport of the heat transfer media inside the unit

3.1.14
electrically-driven heat pump
in the frame of this European Standard, electrically-driven heat pumps denote vapour compression cycle heat pumps, which incorporate a compressor that is driven by an electric motor

3.1.15
energy need for domestic hot water
heat to be delivered to the needed amount of domestic hot water to raise its temperature from the cold network temperature to the prefixed delivery temperature at the delivery point, not taking into account the technical building thermal systems

3.1.16
energy need for heating or cooling
heat to be delivered to or extracted from a conditioned space to maintain the intended temperature during a given period of time, not taking into account the technical building thermal systems

NOTE 1 The energy need is calculated and cannot easily be measured.

NOTE 2 The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control if they are taken into account by increasing (decreasing) the effective temperature for heating (cooling) and not included in the heat transfer due to the heating (cooling) system.

3.1.17
energy use for space heating or cooling or domestic hot water
energy input to the heating, cooling or domestic hot water system to satisfy the energy need for heating, cooling (including dehumidification) or domestic hot water, respectively

NOTE If the technical building system serves several purposes (e.g. heating and domestic hot water) it can be difficult to split the energy use into that used for each purpose. It can be indicated as a combined quantity (e.g. energy need for space heating and domestic hot water).

3.1.18
frequency
(statistical) frequency of an event is the number of times the event occurred in the sample. The frequencies are often graphically represented in histograms. In the frame of this European Standard, the frequency of the outdoor air temperature is evaluated based on a sample of hourly-averaged data for one year

3.1.19
heat generator with double service
heat generator which supplies energy to two different systems, e.g. the space heating system and the domestic hot water system in alternate or simultaneous combined operation

3.1.20
heat pump
unitary or split-type assemblies designed as a unit to transfer heat. It includes a vapour compression refrigeration system or a refrigerant/sorbent pair to transfer heat from the source by means of electrical or thermal energy at a high temperature to the heat sink

3.1.21
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)

3.1.22
heat transfer medium
any medium (water, air, etc.) used for the transfer of the heat without change of state. It can be:

— the fluid cooled by the evaporator;

— the fluid heated by the condenser;

— the fluid circulating in the heat recovery heat exchanger

3.1.23
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

3.1.24
heating capacity Φg
heat given off by the unit to the heat transfer medium per unit of time

NOTE If heat is removed from the indoor heat exchanger for defrosting, it is taken into account.

3.1.25
heating or cooling season
period of the year during which a significant amount of energy for heating or cooling is needed

NOTE The season lengths are used to determine the operation period of technical systems.

3.1.26
internal temperature
arithmetic average of the air temperature and the mean radiant temperature at the centre of the occupied zone

NOTE This is the approximate operative temperature according to EN ISO 7726 [14].

3.1.27
low temperature cut-out
temperature at which heat pump operation is stopped and the total heat requirements are covered by a back-up heater

3.1.28
operating range
range indicated by the manufacturer and limited by the upper and lower limits of use (e.g. temperatures, air humidity, voltage) within which the unit is deemed to be fit for use and has the characteristics published by the manufacturer

3.1.29
part load operation
operation state of the technical system (e.g. heat pump) where the actual load requirement is below the actual output capacity of the device

3.1.30
part load ratio

ratio between the generated heat during the calculation period and the maximum possible output from the heat generator during the same calculation period

3.1.31

primary pump
pump mounted in the circuit containing the generator and hydraulic decoupling, e.g. a heating buffer storage in parallel configuration or a hydraulic distributor

3.1.32
produced heat
heat produced by the generator subsystems, i.e. the heat produced to cover the energy requirement of the distribution subsystem and the generation subsystem heat losses for space heating and/or domestic hot water

3.1.33
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

3.1.34
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

3.1.35
seasonal performance factor *SPF*
in the frame of this European Standard, the ratio of the total annual energy delivered to the distribution subsystem for space heating and/or domestic hot water to the total annual input of driving energy (electricity in case of electrically-driven heat pumps and fuel/heat in case of combustion engine-driven heat pumps or absorption heat pumps) plus the total annual input of auxiliary energy

3.1.36
set-point temperature of a conditioned zone
internal (minimum intended) temperature, as fixed by the control system in normal heating mode, or internal (maximum intended) temperature, as fixed by the control system in normal cooling mode

3.1.37
simultaneous operation
simultaneous production of heat energy for the space heating and domestic hot water system by a heat generator with double service, e.g. by refrigerant desuperheating or condensate subcooling

3.1.38
space heating
process of heat supply for thermal comfort

3.1.39
standard rating condition
mandatory condition that is used for marking and for comparison or certification purposes

3.1.40
system thermal losses
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.

3.1.41
technical building system
technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production composed by sub-systems

NOTE 1 A technical building system can refer to one or to several building services (e.g. heating system, space heating and domestic hot water system).

NOTE 2 Electricity production can include cogeneration and photovoltaic systems.

3.1.42
technical bulding sub-system
part of a technical building system that performs a specific function (e.g. heat generation, heat distribution, heat emission)

3.2 Symbols and units

For the purposes of this document, the following symbols and units (Table 2), abbreviations (Table 3) and indices (Table 4) apply.

Table 2 — Symbols and units

Symbol	Name of quantity	Unit
ϕ	Thermal power, heating capacity, heat flow rate	W
η	Efficiency factor	-
θ	Celsius temperature	°C
ρ	Density	kg/m^3
$\Delta\theta$	Temperature difference, - spread	K
Δp	Pressure difference	Pa
b	Temperature reduction factor	-
c	Specific heat capacity	J/(kg·K)
DH	Degree hours	°Ch
COP	Coefficient of performance	W/W
COP_t	Coefficient of performance for the tapping of hot water	W/W
E	Quantity of energy, fuel	J
f	Factor (dimensionless)	-
β	Load factor	-
m'	Mass flow rate	kg/s
N	Number of items	-
k	Factor (fraction)	-
P	Power, electrical power	W
Q	Quantity of heat	J
SPF	Seasonal performance factor	-
t	Time, period of time	s
T	Thermodynamic temperature	K
V	Volume	m^3
V'	Volume flow rate	m^3/s
W	Auxiliary (electrical) energy	J

Table 3 — Abbreviations

ATTD	Accumulated time-temperature difference
DHW	Domestic hot water
SH	Space heating
TTD	Time-temperature difference
VCC	Vapour compression cycle
VAC	Vapour absorption cycle