SLOVENSKI STANDARD
SIST EN ISO 13790:2004

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Toplotne karakteristike stavb - Izračun potrebne energije za ogrevanje prostora (ISO 13790:2004)

Thermal performance of buildings - Calculation of energy use for space heating (ISO 13790:2004)

Wärmetechnisches Verhalten von Gebäuden - Berechnung des Heizenergiebedarfs (ISO 13790:2004)

Performance thermique des bâtiments - Calcul des besoins d'énergie pour le chauffage des locaux (ISO 13790:2004)

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Thermal performance of buildings - Calculation of energy use for space heating (ISO 13790:2004)

Performance thermique des bâtiments - Calcul des besoins d'énergie pour le chauffage des locaux (ISO 13790:2004)

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This European Standard was approved by CEN on 8 September 2003.

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Contents

Foreword

This document EN ISO 13790:2004 has been prepared by Technical Committee CEN/TC 89 "Thermal performance of buildings and building components", the secretariat of which is held by SIS, in collaboration with Technical Committee ISO/TC 163, "Thermal performance and energy use in the built environment", sub-committee 2, "Calculation methods".

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of an identical text or by endorsement, at the latest by December 2004, and conflicting national standards shall be withdrawn at the latest by December 2004.

Annexes A to F are normative. Annexes G to K are informative.

This document includes a Bibliography.

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

Introduction

This standard is one of a series of calculation methods for the design and evaluation of thermal performance of buildings and building components.

The calculation method presented in this standard is based on an energy balance taking account of internal and external temperature variations and, through a utilisation factor, of the dynamic effect of internal and solar gains.

This method can be used for the following applications:

1) judging compliance with regulations expressed in terms of energy targets;

2) comparing the energy performance of various design alternatives for a planned building;

3) displaying a conventional level of energy performance of existing buildings;

4) assessing the effect of possible energy conservation measures on an existing building, by calculation of the energy use with and without the energy conservation measure;

5) predicting future energy resource needs on a national or international scale, by calculating the energy uses of several buildings representative of the building stock.

Reference can be made to other International Standards or to national documents for input data and detailed calculation procedures not provided by this standard. In particular, this applies to the calculation of the efficiency or the heat loss of the heating systems.

Unlike EN 832, whose scope is restricted to residential buildings, this standard can be applied to both residential and non-residential buildings. The most important changes in EN ISO 13790 compared to EN 832:1998, "*Thermal performance of buildings - Calculation of energy use for heating - Residential buildings*", are:

1. Ventilation rates are calculated according to standards prepared by CEN/TC 156;

2. Clause 11 has been made simpler, and energy use is calculated from heat use according to existing International Standards or, by default, to national documents;

3. A normative method has been included to calculate the effect of intermittence.

4. New input data have been included for non-residential buildings, in particular for utilisation factors.

For all these reasons, calculation using EN ISO 13790 gives results that may slightly differ from those obtained with EN 832.

1 Scope

This standard gives a simplified calculation method for assessment of the annual energy use for space heating of a residential or a non-residential building, or a part of it, which will be referred to as "the building".

It does not apply to buildings with air conditioning systems likely to provide space cooling during the heating season.

This method includes the calculation of:

1. the heat losses of the building when heated to constant internal temperature;

2. the annual heat required to maintain the specified set-point temperatures in the building;

3. the annual energy required by the heating system of the building for space heating, using heating system characteristics which are to be found in specific European or International Standards, or, by default, in national documents.

The building can have several zones with different set-point temperatures, and can have intermittent heating.

The calculation period is the month. For residential buildings the calculation can also be performed for the heating season. Monthly calculation gives correct results on an annual basis, but the results for individual months close to the beginning and the end of the heating season can have large relative errors. Annex J provides some information on the accuracy of the method.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

EN ISO 13370:1998, *Thermal performance of buildings – Heat transfer via the ground – Calculation methods (*ISO 13370:1998*).*

EN ISO 13789, *Thermal performance of buildings – Transmission heat loss coefficient – Calculation method (ISO 13789:1999).*

3 Terms and definitions

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

3.1
calculation period

time period for the calculation of heat losses and gains

NOTE The calculation period is the month. For residential buildings the calculation can also be performed for the heating season.

3.2
external temperature

temperature of external air

NOTE For transmission heat loss calculations, the radiant temperature of the external environment is supposed equal to the external air temperature; long-wave transmission to the sky is considered in F.5.

3.3
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 ISO 7726, *Ergonomics of the thermal environment - Instruments for measuring physical quantities.*

3.4
set-point temperature

internal temperature, as fixed by the control system in normal heating mode

3.5
set-back temperature

minimum internal temperature to be maintained during reduced heating periods

3.6
adjusted internal temperature

constant virtual internal temperature leading to the same heat loss as intermittent heating

3.7
heated space

room or enclosure heated to a given set-point temperature

3.8
unheated space

room or enclosure which is not part of the heated space

3.9
heat use

heat to be delivered to the heated space by an ideal heating system to maintain the set-point temperature during a given period of time

NOTE The heat use can include additional building heat loss resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing the set-point temperature and not included in the heat loss due to the heating system.

3.10
energy use for space heating

thermal energy to be delivered to the heating system to satisfy the heat use

3.11
intermittent heating

heating pattern where normal heating periods alternate with reduced heating periods

3.12
modes of intermittence

during intermittent heating, the heating system is operated according to either of the following modes:

3.12.1 **normal mode**: the heating system functions to maintain the internal temperature at the value it would have with continuous heating;

3.12.2 **cut-off mode**: the heating system does not provide heat;

3.12.3 **reduced heating power mode**: the heating system provides a heat flow rate lower than in normal heating;

3.12.4 **set-back mode**: heat flow rate is controlled to maintain a set-back temperature;

3.12.5 **boost mode**: the heating system runs at full power in order to reach the set-point temperature at or before the end of the reduced heating period

NOTE Depending on the control system, the boost mode can start according to two different strategies:

a) fixed time boost: the start of the boost mode is fixed by the user;

b) optimised boost: the time when the set-point internal temperature is recovered is fixed by the user, and the control system optimises the start of the boost mode, taking account of the external and internal temperatures.

3.13
heated zone

part of the heated space with a given set-point temperature, throughout which the internal temperature is assumed to have negligible spatial variations

3.14
heat transfer coefficient

heat flow rate between two zones divided by the temperature difference between both zones

3.15
heat loss coefficient

heat transfer coefficient from the heated space to the external environment

NOTE The heat loss coefficient of the building cannot be used when the multi-zone calculation method according to annex B is applied

3.16
building heat loss

heat transferred from heated space to the external environment by transmission and by ventilation, during a given period of time

3.17
ventilation heat loss

heat lost with the air leaving the heated space either by exfiltration or ventilation

3.18
transmission heat loss

heat loss by transmission through the building envelope and through the ground

3.19
heat gains

heat generated within or entering into the heated space from heat sources other than the space and hot water heating systems

NOTE These include internal heat gains and solar gains.

3.20
internal heat gains

heat provided within the building by occupants (sensible metabolic heat) and by appliances other than the space and hot water heating systems (lighting, domestic appliances, office equipment, etc.)

3.21
solar gains

heat provided by solar radiation entering into the building through windows or passive solar devices such as sunspaces, transparent insulation and solar walls

NOTE Active solar devices such as solar collectors are considered as part of the heating system.

3.22
solar irradiation

incident solar heat per area over a given period

3.23
utilisation factor

factor reducing the total monthly or seasonal heat gains to obtain the resulting reduction of the heat use

3.24
recovered heat

heat recovered from the environment or from heating and hot water systems (including auxiliary equipment), if not directly taken into account in a reduction of the heating system losses

3.25
ventilation heat recovery

heat recovered from the exhaust air

3.26
heating system losses

total of the heat lost by the heating system, including recovered system heat loss

4 Symbols and abbreviations

Table 1 — Symbols and units

Symbol	Quantity	Unit
A	area	m^2
a	numerical parameter in utilisation factor	-
b	correction factor for unheated zones	-
C	effective heat capacity of a heated space	J/K
c	specific heat capacity	J/(kg·K)
d	layer thickness	m
F	factor	-
g	total solar energy transmittance of a building element	-
I	solar irradiance	J/m^2
H	heat transfer coefficient, heat loss coefficient	W/K
h	surface coefficient of heat transfer	$W/(m^2·K)$
L	length	m
N	number	
Q	quantity of heat or energy	J
R	thermal resistance	$m^2·K/W$
T	thermodynamic temperature	K
t	time, period of time	s
U	thermal transmittance	$W/(m^2·K)$
V	volume of air in a heated zone	m^3
$\dot{V}$	airflow rate	m^3/s
Φ	heat flow rate, heating power	W
Z	heat loss parameter for solar walls	$W/(m^2·K)$
α	absorption coefficient of a surface for solar radiation	-
γ	gain/loss ratio	-
δ	ratio of the accumulated internal-external temperature difference when the ventilation is on to its value over the calculation period	-
ε	emissivity of a surface for thermal radiation	-

Symbol	Quantity	Unit
η	efficiency, utilisation factor for the gains	-
κ	factor related to heat losses of ventilated solar walls	-
θ	Celsius temperature	°C
ρ	density	kg/m³
σ	Stefan-Boltzmann constant ($\sigma = 5{,}67 \times 10^{-8}$)	W/(m²·K⁴)
τ	time constant	s
χ	heat capacity per area	J/(m²·K)
ξ	ratio of the effects of a change in heating flow rate on the internal temperature and on the structure temperature	-
ζ	effective part of the heat capacity	-
ω	ratio of the total solar radiation falling on the element when the air layer is open to the total solar radiation during the calculation period	-

NOTE Hours can be used as the unit of time instead of seconds for all quantities involving time (i.e. for time periods as well as for air change rates), but in that case the unit of energy is Watt-hours [Wh] instead of Joules.

Table 2 — Subscripts

C	capacity, calculation, convective	f	form, final	r	radiative, recovered, reduced
F	frame	g	gains	s	solar, sunspace
G	ground	h	heating, heated, hemispherical	sb	set back
L	loss	hol	holidays	se	surface external
P	related to power	hw	hot water	si	surface internal
S	shading	i	internal	ss	surface-sky average
T	transmission	ih	intermittent heating	sw	solar wall
V	ventilation	*i,j,k,m,n*	dummy integers	t	transparent insulation
a	air	l	layer	th	heating system
ad	adjusted	m	metabolic, month	u	unheated
ap	appliances	nh	no heating	v	ventilation
bh	boost heating	o	overall	w	window
c	structure	p	partition wall	*y, z*	zone number
d	design, daily, direct	pp	peak power	⊥	perpendicular
e	exterior, envelope	ps	permanent shading	0	base, reference

5 Outline of the calculation procedure and required data

5.1 Energy balance

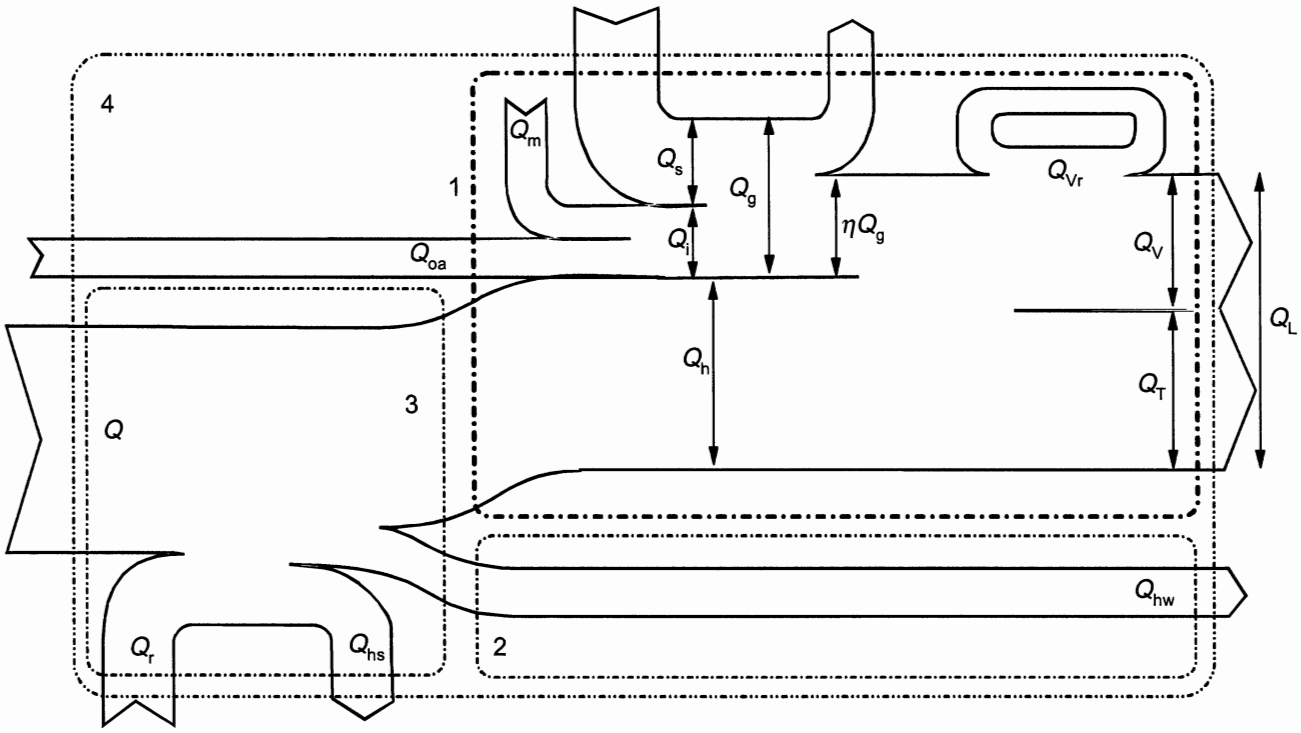
The energy balance includes the following terms (only sensible heat is considered):

5. transmission and ventilation heat loss from the heated space to the external environment;
6. transmission and ventilation heat transfer between adjacent zones;
7. internal heat gains;
8. solar gains;
9. generation, distribution, emission and control losses of the space heating system;
10. energy input to the space heating system.

It may also include recovered energy from various sources.

NOTE As heat gains may induce internal temperature to rise above the set-point, the resulting additional heat loss is taken into account through a utilisation factor reducing heat gains.

The main terms of the energy balance are schematically illustrated in Figure 1.



Key

Q	Energy use for heating	Q_h	Heat use
Q_{oa}	Heat from other appliances	Q_V	Ventilation heat loss
Q_r	Recovered energy	Q_{Vr}	Ventilation heat recovery
Q_{hs}	Losses from the heating system	Q_T	Transmission heat loss
Q_m	Metabolic heat	Q_{hw}	Heat for hot water preparation
Q_s	Passive solar gains	Q_L	Total heat loss
Q_i	Internal gains	1	Boundary of the heated zone
Q_g	Total gains	2	Boundary of the hot water system
$\eta\ Q_g$	Useful gains	3	Boundary of the heating plant
		4	Boundary of the building

Figure 1 – Energy balance of a building

5.2 Calculation procedure

The calculation procedure is summarised below. In addition, the special approach given in annex A shall be followed when applying this standard to existing buildings.

1) Define the boundaries of the heated space and, if appropriate, of different zones and unheated spaces, according to 5.3.

2) In case of intermittent heating or intermittent ventilation define, within the calculation period, the periods having different heating and ventilation patterns (e.g. day, night, weekend) according to clause 6.

3) For a single zone calculation, calculate the heat loss coefficient of the heated space according to clause 7; or for a multi-zone calculation, follow the procedure in annex B.

4) For seasonal calculation, define or calculate the length and climatic data of the heating season, according to 9.2.

Then, for each calculation period (month or heating season):

5) calculate the adjusted internal temperature for each period according to clause 6;

6) calculate the heat loss, Q_L, according to clause 7;

7) calculate the internal heat gains, Q_i, according to 8.1;

8) calculate the solar gains, Q_s, according to 8.2;

9) calculate the utilisation factor for heat gains, η, according to 9.2;

10) calculate the heat use, Q_h, for all calculation periods, according to clause 9;

11) calculate the annual heat use, Q_h, according to clause 10;

12) calculate the energy use for heating taking into account the losses of the heating system, according to clause 11.

5.3 Definition of boundaries and zones

5.3.1 Boundary of the heated space

The boundary of the heated space consists of all the building elements separating the considered heated space from external environment or from adjacent heated zones or unheated spaces.

5.3.2 Thermal zones

5.3.2.1 Single zone calculation

When the heated space is heated to the same temperature throughout, and when internal and solar gains are relatively small or evenly distributed throughout the building, the single zone calculation applies.

The division in zones is not required when:

a) set-point temperatures of the zones never differ by more than 4 K, and it is expected that the gain/loss ratios differ by less than 0,4 (e.g. between south and north zones), or

b) doors between zones are likely to be frequently open.

In such cases, even if the set-point temperature is not uniform, the single zone calculation applies. Then the internal temperature to be used is:

$$\theta_i = \frac{\sum_z H_z \theta_{iz}}{\sum_z H_z} \qquad (1)$$

where

θ_{iz} is the set-point temperature of zone z;

H_z is the heat loss coefficient, according to clause 6, but calculated separately for each zone z.

In this case, a unique intermittence pattern shall be chosen.