SLOVENSKI STANDARD
SIST EN ISO 9920:2010

01-junij-2010

Nadomešča:
SIST EN ISO 9920:2008

Ergonomija toplotnega okolja - Ocenitev toplotne izolativnosti in odpornosti oblačil proti vodni pari (ISO 9920:2007, popravljena različica 2008-11-01)

Ergonomics of the thermal environment - Estimation of thermal insulation and water vapour resistance of a clothing ensemble (ISO 9920:2007, Corrected version 2008-11-01)

Ergnomie der thermischen Umgebung - Abschätzung der Wärmeisolation und des Verdunstungswiderstandes einer Bekleidungskombination (ISO 9920:2007, Korrigierte Fassung 2008-11-01)

Ergonomie des ambiances thermiques - Détermination de l'isolement thermique et de la résistance à l'évaporation d'une tenue vestimentaire (ISO 9920:2007, Version corrigé 2008-11-01)

Ta slovenski standard je istoveten z: **EN ISO 9920:2009**

ICS:

13.180	Ergonomija	Ergonomics
61.020	Oblačila	Clothes

SIST EN ISO 9920:2010 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 9920

June 2009

ICS 13.180; 61.020

Supersedes EN ISO 9920:2007

English Version

Ergonomics of the thermal environment - Estimation of thermal insulation and water vapour resistance of a clothing ensemble (ISO 9920:2007, Corrected version 2008-11-01)

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

The text of ISO 9920:2007, corrected version 2008-11-01 has been prepared by Technical Committee ISO/TC 159 “Ergonomics” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 9920:2009 by Technical Committee CEN/TC 122 “Ergonomics” the secretariat of which is held by DIN.

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Endorsement notice

The text of ISO 9920:2007, corrected version 2008-11-01 has been approved by CEN as a EN ISO 9920:2009 without any modification.

INTERNATIONAL STANDARD

ISO 9920

Second edition
2007-06-01

Corrected version
2008-11-01

Ergonomics of the thermal environment — Estimation of thermal insulation and water vapour resistance of a clothing ensemble

Ergonomie des ambiances thermiques — Détermination de l'isolement thermique et de la résistance à l'évaporation d'une tenue vestimentaire

Reference number
ISO 9920:2007(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 9920 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

This second edition cancels and replaces the first edition (ISO 9920:1995), which has been technically revised. It includes major changes to the sections on clothing vapour resistance as well as those dealing with the effects of air movement and body motion on clothing insulation and vapour resistance.

This corrected version of ISO 9920:2007 incorporates the following corrections.

— A value and a symbol missing from Equation (38) have been reinstated.

— In Equation (15), the multiplication symbol has been substituted for an (incorrect) asterisk.

— In Figure A.1, traditional Korean garments erroneously captioned “China” and “Sokchina” have been corrected to read *Chima* and *Sokchima*.

— In Equation (F.8), the subscript of the second representation of “I_{cl}” has been changed to I_{cli}.

— In the description of symbol H given with Equation (F.1), the minus sign missing from the superscript attached to the unit $W \cdot m^{-2}$ has been inserted.

— “Mean skin temperature”, given as the description for $\bar{t}_{cl}$ with Equation (G.6), has been corrected to “mean outer clothing surface temperature”.

— In a number of instances, “weight” has been changed to the accepted ISO term, *mass*.

— Values in Table A.2, No. 134 for I_{cl} and I_T have been corrected.

— Introductory text similar to that present in the first edition has been reinstated in Annex A, and a new introductory text has been added to Annex C.

— Some minor editorial corrections and additions have been made.

Introduction

This International Standard is one of a series of International Standards intended for use in the study of thermal environments. It is a basic document for evaluation of the thermal characteristics of a clothing ensemble (thermal insulation and water vapour resistance). It is necessary to know these values when evaluating the thermal stress or degree of comfort provided by the physical environment according to standardized methods. The thermal characteristics determined in this International Standard are values for steady-state conditions. Properties like “buffering”, adsorption of water and similar are not dealt with.

The emphasis in this International Standard is on the estimation of the thermal characteristics. The heat and vapour resistance may also be measured directly, and this is discussed in the annexes.

This International Standard does not deal with the local thermal insulation on different body parts, nor the discomfort due to a non-uniform distribution of the clothing on the body.

Man’s thermal balance in neutral, cold and warm environments is influenced by the clothing worn. For evaluating the thermal stress on human beings in the cold (IREQ, see ISO/TR 11079, insulation index), neutral environments (PMV-PPD, see ISO 7730, indices) and the heat (predicted heat strain, see ISO 7933, index), it is necessary to know the thermal characteristics of the clothing ensemble, i.e. the thermal insulation and the water vapour resistance.

Ergonomics of the thermal environment — Estimation of thermal insulation and water vapour resistance of a clothing ensemble

1 Scope

This International Standard specifies methods for estimating the thermal characteristics (resistance to dry heat loss and evaporative heat loss) in steady-state conditions for a clothing ensemble based on values for known garments, ensembles and textiles. It examines the influence of body movement and air penetration on the thermal insulation and water vapour resistance.

This International Standard does not

— deal with other effects of clothing, such as adsorption of water, buffering or tactile comfort,

— take into account the influence of rain and snow on the thermal characteristics,

— consider special protective clothing (water-cooled suits, ventilated suits, heated clothing), or

— deal with the separate insulation on different parts of the body and discomfort due to the asymmetry of a clothing ensemble.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
thermal insulation
I
resistance to dry heat loss between two surfaces, expressed in square metres Kelvin per watt ($m^2 \cdot K \cdot W^{-1}$)

NOTE 1 In this International Standard it is considered as the *equivalent uniform thermal resistance*, or thermal insulation, on a human body. This is the clothing *heat resistance* (thermal insulation) that, when uniformly covering the whole body surface (including hands, face, etc.), would result in the same heat loss as the actual, possibly non-uniform, clothing heat resistance. This heat resistance is the quotient of the temperature gradient between the surfaces (the driving force) over the dry heat loss per unit of body surface area (the flux):

$$I = \frac{\text{temperature gradient}}{\text{heat loss per unit of body surface area}} \quad (1)$$

For the human body, this resistance can be divided into specific layers, as illustrated in Figure 1 (see also Annex F).

NOTE 2 Because of the special definition of thermal insulation in this International Standard, it is usually expressed in clo, the unit of thermal insulation of clothing. Although it can be converted into SI units in similar fashion to the thermal insulation of, for example, textile samples [symbol: R_{ct}; 1 clo = 0,155 ($m^2 \cdot K \cdot W^{-1}$)], the meaning is not the same.

2.1.1
total insulation
I_T
thermal insulation from the body surface to the environment (including all clothing, enclosed air layers and boundary air layer) under reference conditions, static

See Figure 1.

NOTE Based on Equation (1), it is expressed as:

$$I_T = \frac{\bar{t}_{sk} - t_o}{H} \quad (2)$$

where

$\bar{t}_{sk}$ is the mean skin surface temperature, in degrees Celsius;

t_o is the operative temperature, in degrees Celsius (in most cases equal to the air temperature, t_a);

H is the dry heat loss per square metre of skin, in watts per square metre.

2.1.2
basic insulation
intrinsic insulation
I_{cl}
thermal insulation from the skin surface to the outer clothing surface (including enclosed air layers) under reference conditions, static

See Figure 1.

NOTE Based on Equation (1), it is expressed as:

$$I_{cl} = \frac{\bar{t}_{sk} - t_{cl}}{H} \quad (3)$$

where $\bar{t}_{cl}$ is the mean outer clothing surface temperature, in degrees Celsius.

2.1.3
air insulation
I_a
thermal insulation of the boundary (surface) air layer around the outer clothing or, when nude, around the skin surface

See Figure 1.

NOTE 1 Based on Equation (1), it is expressed as

$$I_a = \frac{\bar{t}_{cl} - t_o}{H} \quad (4)$$

NOTE 2 The dry heat loss is composed of radiant and convective heat loss (see Annex G). These heat transfers through the clothing layers are not considered separately in this International Standard; for the air layer, they can be considered separately. The alternative representation is then:

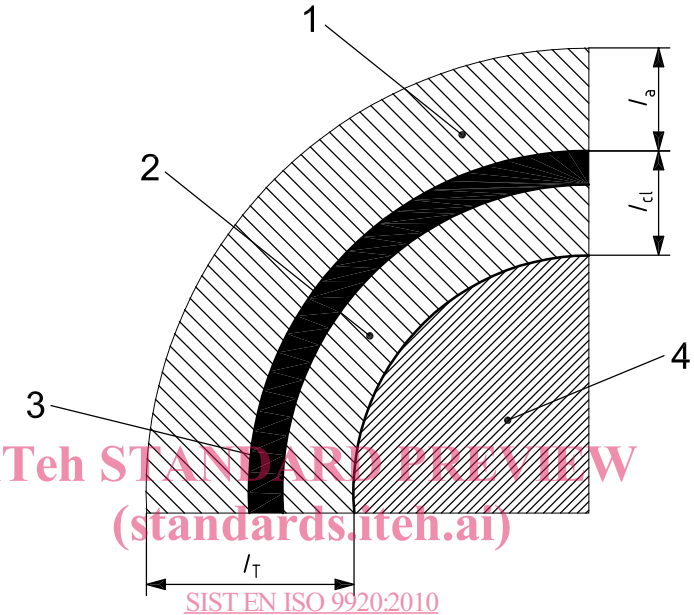
$$I_a = \frac{1}{h_c + h_r} \quad (5)$$

where

h_c is the convective heat transfer coefficient, in watts per square metre Kelvin ($W \cdot m^{-2} \cdot K^{-1}$);

h_r is the radiative heat transfer coefficient, in watts per square metre Kelvin ($W \cdot m^{-2} \cdot K^{-1}$).

NOTE 3 Such values are defined for standardized conditions (static body, wind still, i.e. speed $< 0{,}2\ m \cdot s^{-1}$). When air movement is present, or when the body moves, this will affect the insulation (typically lowering it), in which case, it is referred to as *resultant* or *dynamic heat resistance*.



Key

1 surface (or boundary) air layer
2 enclosed air layer
3 clothing
4 body

Figure 1 — Schematic representation of total, basic and air insulations

2.1.4
clothing area factor
f_{cl}
ratio of the outer surface area of the clothed body to the surface area of the nude body

NOTE 1 The outer surface area of a clothed person, A_{cl}, is greater than the surface area of a nude body, A_{Du}. Their ratio is therefore larger than 1:

$$f_{cl} = \frac{A_{cl}}{A_{Du}} \tag{6}$$

NOTE 2 Basic and air insulation do not simply add up to total insulation. This is explained by the difference in surface area between the outer clothing surface and the skin surface. Owing to this higher surface area, the insulative effect for the body of the air insulation is reduced the thicker the clothing (the larger the outer clothing surface area):

$$I_T = I_{cl} + \frac{I_a}{f_{cl}} \tag{7}$$