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Klasifikacija termoregulacijskih lastnosti

Classification of thermoregulatory properties

Klassifizierung von thermoregulierenden Eigenschaften

Classement des propriétés de thermorégulation

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Foreword

This document (CEN/TR 16422:2012) has been prepared by Technical Committee CEN/TC 248 “Textiles and textile products”, the secretariat of which is held by BSI.

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Introduction

This Technical Report has been developed to help retailers, manufacturers and consumers with the evaluation of thermoregulatory properties of textiles, and selection of the most appropriate methods to define their individual material performance requirements.

In order to encourage the use of the widest possible selection of materials and technologies, this report takes the form of advice and guidance on the tests or groups of tests which would verify the defined performance characteristics of a material or a product composite. It summarises the scope and application of the test described, and provides an indication of suggested range of results for the referred test method or methods to allow the user to grade performance of the material under evaluation. Where a choice of test methods are available for measuring the same parameter on a material, each is described to allow the user of the standard to select the most appropriate method for his requirements.

This report introduces also a system of three performance levels for the different thermoregulatory properties:

— thermal insulation;

— water vapour transmission (breathability);

— air permeability;

— water penetration resistance and repellence;

— liquid sweat management.

The large differences in the conditions of use necessitate a flexible use of the properties and performance levels. This allows a choice of the appropriate level for each property and so to compose a 'product profile', adapted to each specific type of use. There is for example, a significant difference between thermoregulatory properties required for outerwear clothing for cool, windy and rainy weather during low activity, and socks for warm indoor use during intense physical or sport activity. In addition, the work clothing for a shop assistant requires different properties of thermoregulation than the underwear intended for skiing, or home wear for the elderly. The ambient temperature, ambient moisture, wind and level of activity, the contact to skin or other layers of clothing influence the requirements.

At the point of issue, it is recognised that the industry is in a constant state of development with regard to new technology for innovative fibres and performance applications, and that methods required to evaluate these new technologies may in the future be different to those in this report. Subsequent revisions will consider the addition of any new test methods required to keep advice current to the industry and its changing needs.

This document includes annexes. In Annex A, there is consideration for product design and use situations, as material performance is not the sole contributory factor to the thermoregulatory performance of the final product or ensemble in use. This Annex also has examples of marking products. Annex B specifies two alternative methods for liquid sweat transport and liquid sweat buffering.

1 Scope

This Technical Report outlines test methods available for the measurement of thermoregulatory properties of textile materials for use in clothing, and provides guidance on the most suitable methods for selection where choices are available to the user.

The document also provides classification of the thermoregulatory properties in three performance levels.

This Technical Report excludes consideration for the thermoregulatory properties of Personal Protective Equipment (PPE) and clothing items or textile products for which a standard already specifies a particular requirement.

This Technical Report excludes also phase change materials (PCM) and similar smart materials for thermoregulation, for which CEN/TR 16298 may give better guidance.

2 Normative references

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

EN 24920, *Textiles – Determination of resistance to surface wetting (spray test) of fabrics*

EN 29865, *Textiles – Determination of water repellency of fabrics by the Bundesmann rain-shower test*

EN 31092, *Textiles – Determination of physiological effects – Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

EN ISO 9237, *Textiles – Determination of permeability of fabrics to air (ISO 9237)*

EN 20811, *Textiles – Determination of resistance to water penetration – Hydrostatic pressure test.*

ISO 5085-1, *Textiles – Determination of thermal resistance – Part 1: Low thermal resistance*

AATCC TM 195, *Liquid moisture management properties of textile fabrics*

3 Terms and definitions

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

3.1
thermoregulatory properties
properties of textiles which influence the thermoregulation of the human body to maintain the core body temperature at a stable and comfortable state

Note 1 to entry: The properties are thermal insulation, water vapour transmission (breathability), air permeability, water penetration resistance and repellence and liquid sweat management.

3.2
thermal insulation (resistance)
R_{ct}
a quantity specific to textile materials or composites which determines the dry heat flux between the two faces of a material related to area and temperature gradient, expressed in square metres Kelvin per watt ($m^2 \cdot K/W$).

Note 1 to entry: The dry heat flux may consist of one or more conductive, convective and radiant components.

3.3
water vapour transmission (breathability)
WVT
ability of the fabric to transport water vapour expressed either as an absolute value by the water vapour resistance R_{et}, by the water vapour permeability WVP, or by the relative value related to thermal insulation by the water vapour permeability index $i_{mt.}$

3.4
water vapour resistance
$\boldsymbol{R_{et}}$
quantity specific to textile materials and composites, which determines the 'latent' evaporative heat flux between the two faces of a material related to area and water vapour pressure gradient, expressed in square metres pascal per watt ($m^2 \cdot Pa/W$).

Note 1 to entry: The evaporative heat flux may consist of both diffusive and convective components.

3.5
water vapour permeability index
$\boldsymbol{i_{mt}}$
transport properties related to thermal insulation expressed by an index between 0 and 1

3.6
water vapour permeability
WVP
rate of water vapour transmission expressed in grams per square metre hour pascal (g/m^2 Pa h)

3.7
air permeability
AP
volume of air passing perpendicularly through a test specimen under specified conditions of test area, pressure difference and time

3.8
water penetration resistance
WP
resistance to the penetration of water through the material under a specific hydrostatic pressure

3.9
water repellence
ability of fabric to resist surface wetting by water

3.10
liquid sweat management
consists, on one hand, of the uptake or buffering of the sweat from the skin and, on the other hand, of the transport of the sweat from the skin to the ambience

3.11
skin contact products
fabrics or garments intended primarily to be worn next to the skin

Note 1 to entry: Typical examples are underwear, t-shirts, shirts, blouses, trousers, nightwear.

3.12
second layer or intermediate layer products
fabrics or garments intended to be worn above the skin contact products and beneath the outer layer products

Note 1 to entry: Typical examples are sweaters, shirts, vests, blouses.

3.13
outer layer products
fabrics or garments intended to be worn outermost of the layer of clothing, primarily outdoors

Note 1 to entry: Typical examples are overcoats, jackets, trousers, overalls, rainwear.

4 Test methods

4.1 Thermal insulation

4.1.1 General

For the purposes of this Technical Report, two EN or ISO test methods have been identified for the measurement of thermal insulation. Both test methods give the thermal insulation value in $m^2 \cdot K/W$, and the results from the two tests are comparable.

4.1.2 ISO 5085-1, Textiles – Determination of thermal resistance – Part 1: Low thermal resistance

Scope

The standard specifies a method for the determination of the resistance of fabrics, fabric assemblies, or fibre aggregates in sheet form to the transmission of heat through them in the 'steady state' condition. It applies to materials whose thermal resistance is up to approximately 0,2 $m^2 \cdot K/W$.

The method is only suitable for materials of up to 20 mm thickness (if the material is thicker, lateral edge losses are more substantial).

Principle

The temperature drop across a material of known thermal resistance and across a specimen of the material under test in series with it are measured, and from the values obtained, the thermal resistance of the specimen is determined.

Application

Two methods are specified in the standard (single and double plate methods). In the context of this Technical Report, the single plate method should be used.

4.1.3 EN 31092, (ISO 11092) Textiles – Determination of physiological effects – Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)

Scope

The standard specifies test methods for the measurement of the thermal resistance and water vapour-resistance of fabrics, under steady-state conditions.

The application of this measurement technique is restricted to a maximum thermal resistance (and water-vapour resistance) which depends on the dimensions and construction of the apparatus used, for the minimum specifications of the equipment referred to in this international standard. This value is 2 $m^2 \cdot K/W$.

The test conditions used in this standard are not intended to represent specific comfort situations, and performance specifications in relation to physiological comfort are not stated.

Principle

The specimen to be tested is placed on an electrically-heated plate with conditioned air ducted to flow across and parallel to its upper surface as specified in this international standard.

For the determination of thermal resistance, the heat flux through the test specimen is measured after steady-state conditions have been reached.

The thermal resistance R_{ct} of a material is determined by subtracting the thermal resistance of the boundary air layer above the surface of the test apparatus from that of a test specimen plus boundary air layer, both measured under the same conditions.

4.2 Water vapour transmission (breathability)

4.2.1 General

Several methods for testing of the water vapour transmission through textile materials are in use. In the context of this Technical Report EN 31092 should be used, which specifies the measurement of water vapour resistance and water vapour permeability index.

4.2.2 EN 31092 (ISO 11092) Textiles – Determination of physiological effects – Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)

Scope

The application of this measurement technique is restricted to a maximum (thermal resistance and) water-vapour resistance which depends on the dimensions and construction of the apparatus used, for the minimum specifications of the equipment referred to in this International standard. This value is 700 m²·Pa/W.

Principle

The specimen to be tested is placed on an electrically heated plate with conditioned air ducted to flow across and parallel to its upper surface as specified in this international standard.

For the determination of water-vapour resistance, an electrically heated porous plate is covered by a water-vapour permeable but liquid-water impermeable membrane. Water fed to the heated plate evaporates and passes through the membrane as vapour, so that no liquid water contacts the test specimen. With the test specimen placed on the membrane, the heat flux required to maintain a constant temperature at the plate is a measure of the rate of water evaporation, and from this the water-vapour resistance of the test specimen is determined.

The water-vapour resistance R_{et} of a material is determined by subtracting the water-vapour resistance of the boundary air layer above the surface of the test apparatus from that of the test specimen plus boundary air layer, both measured under the same conditions.

Particularly for knitted fabrics and thick cold protective garments, which due to the thickness would get high water vapour resistance values, a more relevant value is the water vapour permeability index i_{mt} which expresses the relation between thermal insulation R_{ct} and water vapour resistance R_{et}.

NOTE For quality control purposes the standard EN ISO 15496, *Textiles - Measurement of water vapour permeability of textiles for the purpose of quality control* can be used to measure the WVP, provided that for a given article the WVR R_{et} value measured according to 4.2.2 is known.

4.3 Air permeability

Testing should be in accordance with EN ISO 9237 (ISO 9237), *Textiles – Determination of permeability of fabrics to air*.

Scope

The standard describes a method for measuring the permeability of fabrics to air and is applicable to most types of fabrics, including industrial fabrics for technical purposes, nonwovens and made-up textile articles that are permeable to air.

Principle

The rate of flow of air passing perpendicularly through a given area of fabric is measured at a given pressure difference across the fabric test area over a given time period.

In the context of this document, the measurement should be carried out at a pressure drop across the specimen test area of 100 Pa and the area of the specimen holder 20 cm^2.

4.4 Water penetration resistance and repellence

4.4.1 General

Protection against liquid water can be expressed with different fabric properties, e.g. resistance to hydrostatic head pressure or water repellence. Several EN or ISO standards are available for testing and for this Technical Report the following can be applied as appropriate, but the results of the different methods may not be compared.

4.4.2 EN 20811 (ISO 811), Textile fabrics – Determination of resistance to water penetration – Hydrostatic pressure test

Scope

The standard specifies a hydrostatic pressure method for determining the resistance of fabrics to penetration by water.

Principle

The hydrostatic head supported by a fabric is a measure of the resistance to the penetration of water through the fabric. A specimen is subjected to a steadily increasing pressure of water on one face, under standard conditions, until penetration occurs in three places. The pressure at which the water penetrates the fabric at the third place is noted. The water pressure may be applied from below or from above the test specimen. The chosen alternative should be stated in the test report. The result is immediately relevant to the behaviour of fabrics articles which are subjected to water pressure for short or moderate periods of time.

In the context of this report, a test speed of 60+/-3 cm H_2O/min should be used.

NOTE The hydrostatic pressure value cmH2O can also be given in the SI unit Pa. 1 cmH_2O corresponds to approximately 100 Pa (1 cmH_2O = 98,066 Pa).

4.4.3 EN 29865 (ISO 9865), Textiles – Determination of water repellency of fabrics by the Bundesmann rain-shower test

Scope

The standard describes a method for the determination of the water repellency of textile fabrics by a rain-shower test known as the Bundesmann method.

The test may be used to assess the effectiveness of finishing procedures for rendering textile fabrics water-repellent.

Principle

Test specimens of textile fabrics are mounted on cups and then exposed to an artificial rain shower under defined conditions. The water repellency is assessed by visual comparison of the wet specimens with reference photographs. The water absorbed by specimens during the test is calculated by weighing. The water penetrating the specimens is collected in the cups and recorded.

4.4.4 EN 24920 (ISO 4920) Textiles – Determination of resistance to surface wetting (spray test) of fabrics

Scope

The standard specifies a spray test method for determining the resistance of any fabric, which may or may not have been given a water-resistant or water-repellent finish, to surface wetting by water.

It is not intended for use in predicting the rain penetration resistance of fabrics, since it does not measure penetration of water through the fabric.

Principle

A specified volume of distilled water is sprayed on a test specimen which has been mounted on a ring and placed at an angle of 45 ° so that the centre of the specimen is at a specified distance below the spray nozzle. The spray rating is determined by comparing the appearance of the specimen with descriptive standards and photographs.

4.5 Liquid sweat management

4.5.1 General

No EN or ISO standards are available for the testing of liquid sweat management through textile fabrics at the time of publication of this document. In the context of this document, the following two test methods as appropriate can be applied for this property.

4.5.2 AATCC Test Method 195-2009, Liquid moisture management properties of textile fabrics

Scope

This test method is for the measurement, evaluation and classification of liquid moisture management properties of textile fabrics. The test method produces objective measurements of liquid moisture management properties of knitted, woven and nonwoven textile fabrics.

The results obtained with this test method are based on water resistance, water repellency and water absorption characteristics of the fabric structure, including the fabric's geometric and internal structure and the wicking characteristics of its fibres and yarns.

Principle

The liquid moisture management properties of a textile are evaluated by placing a fabric specimen between two horizontal (upper and lower) electrical sensors each with seven concentric rings of pins. A predetermined amount of test solution that aids the measurement of electrical conductivity changes is dropped onto the centre of the upward-facing test specimen surface. The test solution is free to move in three directions: radial spreading on the top surface, movement through the specimen from top surface to the bottom surface, and radial spreading on the bottom surface of the specimen. During the test, changes in electrical resistance of specimens are measured and recorded.

The electrical resistance readings are used to calculate fabric liquid moisture content changes that quantify dynamic liquid moisture transport behaviours in multiple directions of the specimen. The summary of the