NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

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Textiles -- Physiological effects -- Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)

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1 Scope

This Standard specifies the determination methods for thermal and water-vapor resistance of physiological effects of textiles under steady-state conditions.

This Standard is applicable to all types of textile fabrics and their products. Coated fabrics, leather and multi-layer composite materials may take this as a reference.

NOTE 1.the application of determination techniques of this Standard is affected by the maximum determination ranges of thermal and water-vapor resistance. The two maximum values depend on the size and structural properties of the instrument (for example, the thermal and water-vapor resistance determination ranges of the instrument applicable to this Standard are generally not less than 2 m2 ? K/W and 700 m2 ? Pa/W).

NOTE 2.the test environment used in this Standard does not represent a specific comfort environment, nor does it provide the performance requirements for comfort.

2 Terms and Definitions

The following term and definitions are applicable to this document.

2.1 thermal resistance

Rct The ratio of the temperature difference on both sides of the specimen to the heat flow per unit area vertically passing through the specimen.

NOTE 1.the dry heat flow may include one or multiple forms of conduction, convection and radiation.

NOTE 2.thermal resistance Rct is expressed in the unit of (m2 ? K/W).

2.2 water-vapor resistance

Ret The ratio of the water vapor pressure difference on both sides of the specimen to the evaporative heat flow per unit area vertically passing through the specimen.

imt. water-vapor permeability index, dimensionless.

Rct0.an instrument constant determined for the determination of thermal resistance Rct, expressed in m2 ? K/W.

Ret0.an instrument constant determined for the determination of water-vapor resistance Ret, expressed in m2 ? Pa/W.

Wd. water-vapor permeability, expressed in g/(m2 ? h ? Pa).

?Tm. latent heat of saturated water vapor when the surface temperature of the test plate is Tm, expressed in W ? h/g.

A. area of the test plate, expressed in m2.

Ta. air temperature in the climate chamber, expressed in ?C.

Tm. temperature of the test plate, expressed in ?C.

Ts. temperature of the thermal retainer, expressed in ?C.

pa. water vapor pressure (when the temperature in the climate chamber is Ta), expressed in Pa.

pm. saturated water vapor pressure (when the surface temperature of the test plate is Tm), expressed in Pa.

va. flow velocity of the air above the surface of the specimen under test, expressed in m/s.

sv. standard deviation of air flow velocity va, expressed in m/s.

R.H.. relative humidity, expressed in %.

H. heating power provided to the test plate, expressed in W.

?Hc. correction amount of heating power in thermal resistance determination.

?He. correction amount of heating power in water-vapor resistance determination.

?. slope of the correction amount curve for the calculated result of ?Hc.

?. slope of the correction amount curve for the calculated result of ?He.

4 Principle Use the specimen to cover the test plate. The test plate, the surrounding thermal retainer, and the protective plate at the bottom can maintain a constant temperature, so that the heat of the test plate can only be dissipated through the specimen, and the air can flow parallel to the upper surface of the specimen. After the test conditions stabilize, determine the heat flow through the specimen, so as to calculate the thermal resistance of the specimen.

The method described in this Standard is to obtain the thermal resistance value Rct of the determined material by subtracting the thermal resistance value of the air layer from the thermal resistance value of the determined specimen plus the air layer. Both determinations are performed under identical conditions.

For the determination of water-vapor resistance, the porous test plate needs to be covered with a breathable but water-impermeable film. The water entering the test plate evaporates, then, passes through the film in the form of water vapor, so no liquid water contacts the specimen.

After the specimen is placed on the film, determine the heat flow required to maintain a constant temperature of the test plate under a certain water evaporation rate, and calculate the water-vapor resistance of the specimen together with the water vapor pressure passing through the specimen.

The method described in this Standard is to obtain the water-vapor resistance value Ret of the determined material by subtracting the water-vapor resistance value of the air layer from the water-vapor resistance value of the determined specimen plus the air layer. Both determinations are performed under identical conditions.

5 Instruments

5.1 Test Part with Temperature and Feed Water Control The test plate consists of a metal plate with a thickness of about 3 mm and an area of at least

0.04 m2 (for example, a square with a side length of 200 mm) fixed on a conductive metal component containing a heating wire (see Figure 1).

For the determination of water-vapor resistance, the test plate shall be porous, which shall be surrounded by a thermal retainer located within the specimen platform.

In an environment of 20 ?C, by using a beam with a wavelength range of 8 ?m ~ 14 ?m to vertically irradiate on the surface of the metal plate and in the mode of hemispheric reflection, determine the radiation emissivity of the metal plate surface, which shall be higher than 0.35.

The surface of the electric heating wire metal component in contact with the porous plate is a groove, so that the water provided by the quantitative water supply device can enter the test plate.

The position of the test plate relative to the specimen platform shall be adjustable, so that the upper surface of the specimen placed on it can remain flush with the specimen platform.

The heat loss in the test plate or temperature test device shall be minimized, for example, by routing the traces along the inner surface of the thermal retainer as much as possible.

The temperature controller, including the temperature sensor of the test plate, shall maintain the resistance is lower than 100 m2 ? Pa/W, the accuracy can be controlled at ? 0.5 ?C; the error of relative humidity shall not exceed ? 3%. When the air temperature Ta in the climate chamber is 20 ?C, the average air flow velocity va measured, at 15mm above the center of the test plate, shall be 1 m/s, and the error shall not exceed ? 0.05 m/s.

It is worth noting that the air flow fluctuates to a certain extent at this point. The relative variation of the air flow velocity can be expressed by the ratio sv/va of the standard deviation to the air flow velocity, and its value is between 0.03 and 0.07.The air flow velocity can be tested using an instrument with a time constant less than 1 s. The data collection frequency shall be no less than 10 times/min, and the total determination time shall be no less than 10 minutes.

6 Specimens

6.1 Material Thickness ? 5 mm The specimen size shall completely cover the surface of the test plate and thermal retainer.

At least 3 specimens shall be taken from each sample, and the specimens shall be flat and wrinkle-free.

Before the test, the specimens shall be conditioned in the test environment specified in 7.3 or

7.4 for at least 12 hours.

6.2 Material Thickness > 5 mm

6.2.1 Specimens with a thickness within this range require a special procedure to avoid heat or water vapor escaping from their edges.

In the determination of thermal resistance, if the thickness of the specimens exceeds 2 times the width b of the thermal retainer, then, corrections shall be made for heat loss at the edges. The deviation of the linear relations between thermal resistance and specimen thickness is determined and corrected in accordance with the formula [1 + (?Rct/Rctm)], and correction is made by determining the Rct value determined by stacking multiple layers of homogenous materials (for example, foam materials) (finally reaching the thickness d of