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Textiles — Determination of dynamic hygroscopic heat generation

Textiles — Détermination de la production de chaleur dynamique hygroscopique

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Foreword

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This document was prepared by Technical Committee ISO/TC 38, *Textiles*.

This second edition cancels and replaces the first edition (ISO 18782:2015), which has been technically revised.

The main changes are as follows:

— in Clause 3, temperature definitions have been added;

— in Clause 7, Figure 1 has been changed from one testing position to 4 testing positions;

— in 7.2.5.5, rectifying plate was introduced for more stable testing;

— in Clause 10.2, the pretreatment process has been added;

— in Annex A, the pretreatment process has been added to the testing method for the determination of air flow rate for high humidity.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In the apparel and clothing market, warm heat-comfort textile material is attracting consumers' attention. It offers comfortable warmth through the combined technology of the hygroscopic heat generation and heat insulation.

The phenomenon of the hygroscopic heat generation is known as a common function of natural fibres especially, but not so much for synthetic fibres. Therefore, the synthetic fibre producers have been developing fibres and textiles with an appropriate warm-feeling property.

This document provides a test method to obtain the practical heat generation of textiles under wearing conditions.

The apparatus used in this test method has multiple test positions. So, this method is practical and economical with high accuracy.

Textiles — Determination of dynamic hygroscopic heat generation

1 Scope

This document specifies a test method for the determination of hygroscopic heat generated by flowing low to high humidity air on one side of a surface. It is applicable to all kinds of sheet-shaped textile materials.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 105-F02, *Textiles — Tests for colour fastness — Part F02: Specification for cotton and viscose adjacent fabrics*

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
generated hygroscopic heat
hygroscopic heat generated by the loss of kinetic energy when gaseous water molecules are adsorbed on a surface of textile material

3.2
temperature at low humidity
$T_{initial}$
initial equilibrium temperature at measurement side of a specimen when the low humidity air is supplied

3.3
generated hygroscopic heat temperature
ΔT
temperature difference between the initial equilibrium temperature and the temperature when the high humidity air is supplied on measurement side of a specimen

3.4
maximum temperature at high humidity
T_{max}
maximum temperature at measurement side of a specimen when high humidity air is supplied

3.5
maximum generated hygroscopic heat temperature
ΔT_{max}
maximum value of the generated hygroscopic heat temperature ΔT

4 Principle

When the air supply is switched from low humidity to high humidity in instant, the temperature at the specimen increases and reaches a peak due to the hygroscopic heat generation. The temperature at one side of specimen is measured during this air change and the peak temperature is determined as ΔT_{max}. In this test method, the high humidity air flow rate is determined by a cotton control specimen in which the ΔT_{max} becomes 2,8 °C ± 0,3 °C.

5 Testing condition

5.1 Low humidity air

The air is taken from the atmosphere of the constant temperature and humidity chamber (7.1) in which the temperature is controlled at 20 °C ± 2 °C and the relative humidity at (40 ± 3) %. The air flow rate is set at 1,0 l/min ± 0,1 l/min.

5.2 High humidity air

The air in the constant temperature and humidity chamber (7.1) is passed through bubbling bottle (7.2.2) and supplied to specimen as a high humidity air.

NOTE High humidity air is controlled by the air flow rate only; therefore, humidity measurements are not essential. However, the humidity of high humidity air has been known as (90 ± 5) % RH.

6 Reagents and materials

6.1 Water, distilled water, ion exchanged water, grade 3 water according to ISO 3696 or equivalent for humidifying air in a bubbling bottle (7.2.2).

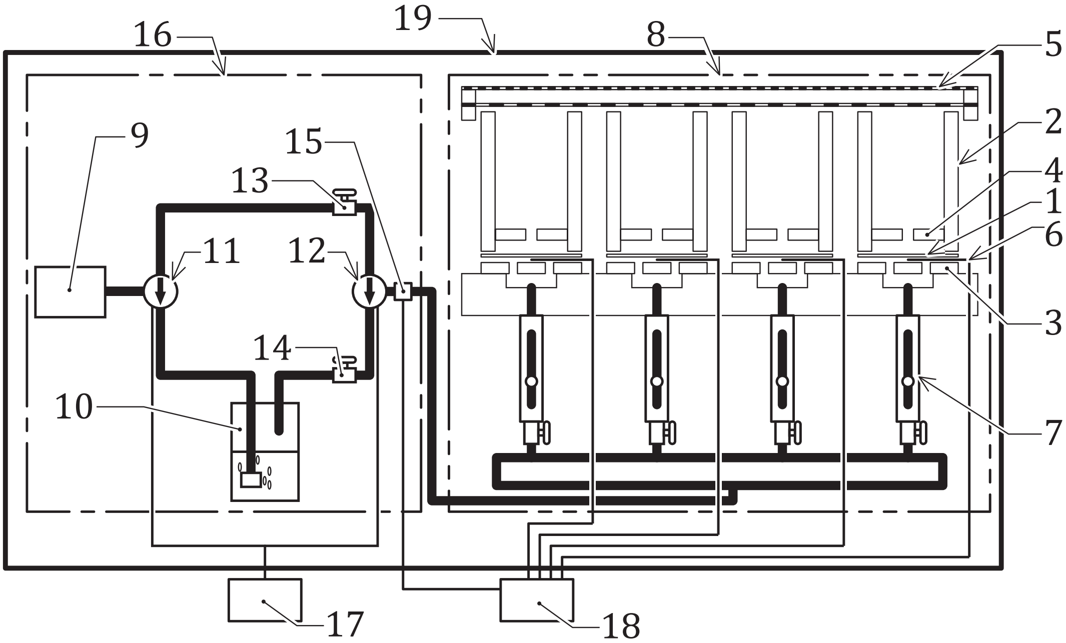
6.2 Control specimen, a cotton adjacent fabric as specified in ISO 105-F02.

7 Apparatus

7.1 Constant temperature and humidity chamber or room, capable of maintaining the temperature at 20 °C ± 2 °C and the relative humidity at (40 ± 3) %. The hygroscopic heat generation testing apparatus (7.2) is placed in the chamber or room.

7.2 Hygroscopic heat generation testing apparatus, shown in Figure 1. All devices are placed in the chamber (7.1) in case of cabin type. If in case the oven type, the switching valve and control device

(7.2.3) and monitoring recorder (7.3) are placed in the outside of the chamber. Air is supplied from one air supply path to four measuring units. An example of practical testing apparatus is shown in Annex C.



Key

Key

1	specimen
2	specimen holder
3	specimen table
4	air lid
5	rectifying plate
6	thermometer
7	flowmeter with regulating valve
8	measuring units
9	air pump
10	air bubbling bottle with water
11, 12	switching valve
13, 14	flow control valve
15	humidity sensor
16	air supply path
17	control device
18	monitoring recorder
19	constant temperature and humidity chamber

Figure 1 — Schematic diagram of the testing apparatus

7.2.1 Air pump, capable of collecting air from the atmosphere of the chamber (7.1) and supplying air to the specimen at a rate of 1,0 l/min ± 0,1 l/min.

7.2.2 Bubbling bottle, consisting of an air-tight bottle with an air inlet tube attached to a porous cylinder such as air stones to make fine air bubbles and with air outlet tube to collect high humidity air after bubbling. Completely submerge the porous cylinder in water during testing.

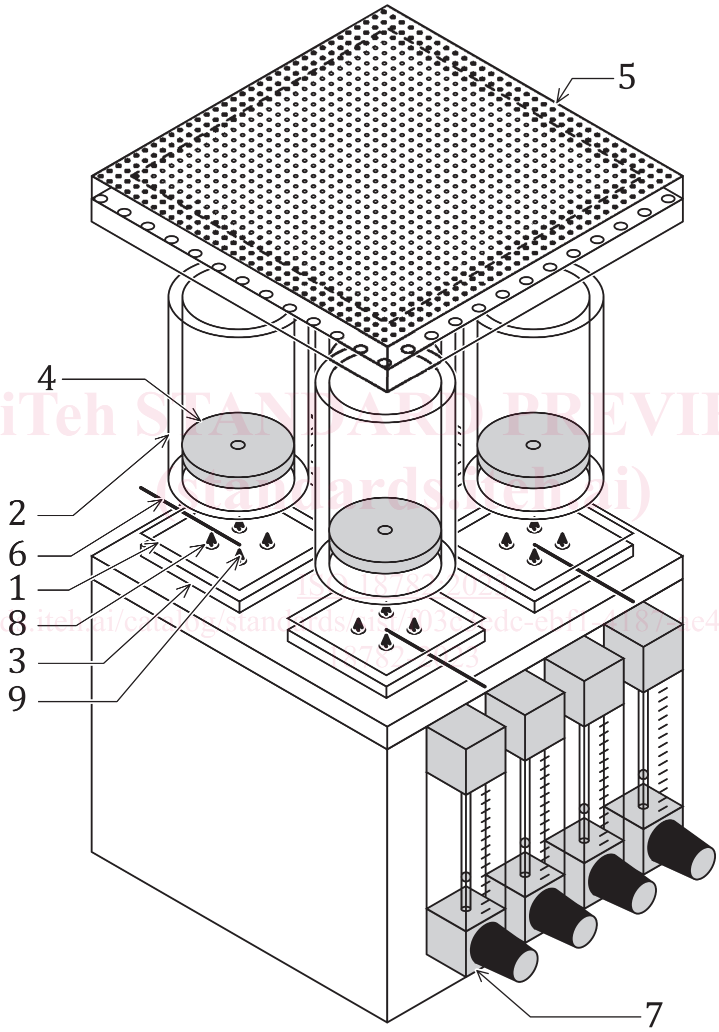
7.2.3 Switching valve with control device, used for switching to low humidity air path (11, 13, 12 and 15 in Figure 1) or high humidity air path (11, 14, 12 and 15 in Figure 1) passed through a bubbling bottle (10 in Figure 1 and 7.2.2).

7.2.4 Humidity sensor, used for detecting a humidity of air supply path, from 5 % RH to 100 % RH, with accuracy ±5 % RH.

7.2.5 Measuring units and rectifying plate, four measuring units (as shown in Figure 1) where each unit consists of: a specimen table (7.2.5.1), a specimen holder (7.2.5.2), a thermometer (7.2.5.3), and a flowmeter with regulating valve (7.2.5.4). Each measuring unit is positioned as shown in Figure 2, and a rectifying plate (7.2.5.5) is stacked to cover the entire measuring part.

7.2.5.1 Specimen table, consisting of a board of polystyrene foam with a square of 50 mm± 5 mm, a thickness of 7 mm ± 2 mm and 4 air holes with a diameter of 5,0 mm ± 0,3 mm each. The holes are located 10 mm from the centre of the table in diagonal positions in the square.

EXAMPLE For example, polystyrene foam with a thermal conductivity of 0,035 W/m K can be used as a heat-insulating material.



Key

1	specimen	6	thermometer
2	specimen holder	7	flowmeter with regulating valve
3	specimen table	8	air holes
4	air lid	9	air flow
5	rectifying plate		

Figure 2 — Measuring unit and rectifying plate

7.2.5.2 Specimen holder, consisting of a transparent acrylic cylinder with an outside diameter of 50 mm ± 5 mm, a thickness of 5 mm ± 3 mm and a height of 80 mm ± 5 mm. The air lid of the holder is placed at a height of 5 mm ± 1 mm from the bottom and an insulation material (polystyrene foam with a vent hole of a diameter of 3 mm ± 1 mm) is placed in the centre.

7.2.5.3 Thermometer, with a film-type sensor as shown in Figure 3, placed at the centre of the specimen table (7.2.5.1) and covered by a specimen. A film-type sensor has a width of about 4 mm and a thickness of about 0,2 mm, a length is greater than 25 mm. The accuracy is ±1,2 %.

Figure 3 — Sample of film type thermometer

7.2.5.4 Flowmeter with regulating valve, adjustable air flow rate supplying to specimen with a needle valve or similar. The maximum measurable flow rate shall be 1,0 l/min or more, and the measurement accuracy shall be ±10 %.

7.2.5.5 Rectifying plate, two acrylic frame openings, each covered with different types of perforated metal plates, stacked and fixed together. The upper and lower frames are made of acrylic, both with external dimensions of 200 mm ± 2 mm square, internal dimensions of 180 mm ± 2 mm square and a height of 10,0 mm ± 0,5 mm. The upper perforated metal plate is made of aluminium, with dimensions of 200 mm ± 2 mm square, a thickness of 1,0 mm ± 0,1 mm, a hole diameter of 1,0 mm ± 0,1 mm and a pitch of 2,0 mm ± 0,1 mm. The lower perforated metal plate is made of aluminium with dimensions of 200 mm ± 2 mm square, thickness of 0,5 mm ± 0,1 mm, hole diameter of 3,0 mm ± 0,1 mm and pitch of 5,0 mm ± 0,1 mm. The lower frame, the lower perforated metal plate, the upper frame and the upper perforated metal plate, in that order, are placed on top of each other and fixed so that the opening of the frame is covered by the perforated metal plate. As shown in Figure 1 and Figure 2, the rectifying plate is placed in contact to top side of the specimen holder (7.2.5.2).

7.3 Monitoring recorder, connected to the humidity sensor (7.2.4) and the thermometer (7.2.5.3), which continuously records the humidity in the flow path and the temperature of the specimen. When using an electronic recording medium, the recording interval is 1 s or less.

7.4 Drying oven, able to maintain a temperature at 105 °C ± 3 °C.