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Textiles — Industrial washing and finishing procedures for testing of workwear

Textiles — Méthodes de blanchissage et de finition industriels pour les essais des vêtements de travail

Reference number
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Contents

Annex

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15797 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 2, *Cleansing, finishing and water resistance tests*.

Annex A forms a normative part of this International Standard.

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Introduction

The methods described in this International Standard simulate the effect of industrial laundering on workwear.

Provision is made for eight different washing procedures based on the use of a front- or side-loading horizontal rotating drum type washer/extractor.

Each washing procedure is considered to represent a single industrial wash.

This International Standard also specifies two drying/finishing test procedures:

a) Tumble drying

b) Tunnel/cabinet finishing

A complete laundering test consists of a washing and a drying/finishing procedure.

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Textiles — Industrial washing and finishing procedures for testing of workwear

1 Scope

1.1 This International Standard specifies test procedures and equipment which can be used in the evaluation of cotton, polyester/cotton and reverse blend workwear intended to be industrially laundered. They serve as a basis for testing relevant properties such as e.g. dimensional stability, colour fastness, creasing and seam puckering.

1.2 This International Standard does not provide instructions and specifications for the procedures and equipment to be used by industrial launderers.

1.3 Since it is not possible, in practice, to reproduce industrial laundry processes (washing and finishing) in a laboratory setting, this International Standard provides an approach using defined intermediate scale equipment and exacting test procedures which may be used for the evaluation of workwear intended to be laundered industrially.

1.4 Testing of the workwear in the actual industrial laundering equipment and processes intended to be used is advisable when finally determining product and process compatibility.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 3071:1980, *Textiles — Determination of pH of the aqueous extract*

ISO 3759:1994, *Textiles — Preparation, marking and measuring of fabric specimens and garments in tests for determination of dimensional change*

3 Terms and definitions

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

3.1
cage
basket or inner drum
rotating container within which the load is held during the process and which is generally fabricated from perforated stainless steel

3.2
dead volume
volume of water in drum such that the surface lies at a tangent with the inside of the cage in the stationary position

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3.3
domestic laundering
washing/finishing of textiles according to size and volume needed by a single household

NOTE Usual size of cage is approximately 60 l.

3.4
drum
outer drum
non-rotating container within which the cage rotates

3.5
load ratio
ratio of dry load, in kilograms, to net cage volume in litres

NOTE Net cage volume is given by net volume of lifters, back wall and door.

3.6
g-factor
factor defined by the formula

$$0{,}56 \times \left(\frac{n}{1\,000}\right)^2 \times d$$

where

n is the number of revolutions per minute (r/min);

d is the cage diameter in millimetres.

3.7
industrial laundering
professional laundering of workwear in greater quantities than domestic laundering

3.8
liquor ratio
ratio of dry load, in kilograms, to total amount of water, in litres

3.9
workwear
garment specifically designed to be worn in the workplace

NOTE Its attributes are determined by the reason for its use, the activity in the workplace and the requirement to restore it for re-use.

4 Principle

The specimen (or relevant number of specimens) is washed in a washer/extractor and dried/finished according to one of the specified procedures. If multiple laundering cycles are required, each wash process shall be followed by drying/finishing.

5 Apparatus

5.1 Washer/extractor

a) Front- or side-loading open pocket horizontal rotating drum type.

b) Cage volume: 220 l to 250 l.

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c) Diameter of cage: 750 mm to 850 mm.

d) Depth of cage: 400 mm to 600 mm.

e) Ratio (diameter of cage to depth of cage): 1,5 $\pm$ 15 %.

f) Dead volume: 10 l to 20 l.

g) Lifting vanes (ribs): three; each having a height 10 % to 12 % of diameter of cage; base width $<$ 100 mm.

h) Heating: direct steam, thermostatically controlled.

i) g-factors: wash 0,75 $\pm$ 10 %; drain 0,75 $\pm$ 10 %; interspin 50 to 100; final extraction 250 to 350.

j) Programmable extract speeds.

k) Reversible action, 5 to 10 revolutions in one direction, then reverse.

l) Time rotating at full washing speed to total washing time: 80 %.

5.2 Tumble dryer

a) Air vented batch drying tumbler with a system for detecting the moisture content of the exhaust air to a tolerance of $\pm$ 5 %.

b) Thermostatically-controlled heating.

c) Diameter of cage: 900 mm to 1 100 mm.

d) Depth of cage: 630 mm to 1 000 mm.

e) Cage volume: 600 l to 720 l.

f) g- factor: 0,7 to 1,0.

g) Reversing action: yes.

h) Nominal evaporation rate: 45 l/h $\pm$ 20 %.

i) Radial airstream: yes.

j) Perforated drum: yes.

k) Perforated cage: yes.

5.3 Finisher

a) Batch-loaded steam cabinet.

b) Capacity: 8 to 18 pieces/garments.

c) Spray steam pressure: 2 bar to 5 bar (200 kPa to 500 kPa).

d) Specific volume flow (within cabinet): 6 900 m^3/m^2 h to 8 900 m^3/m^2 h.

e) Direction of air flow: top to bottom.

f) Temperature setting: adjustable.

g) Inlet temperature: 160 $^\circ$C option required.

h) Distance from hanger to hanger: 75 mm $\pm$ 10 mm.

5.4 Loading ballast

Consisting of clean workwear garments (lab coats, bib and brace, overalls, jackets, trousers and boilersuits) not previously washed more than 100 times and similar to the type of garment and fabric of the specimen (e.g. polyester/cotton or cotton), and the colour (e.g. white, coloured or fluorescent coloured). In cases where the ballast material may have a significant influence on the test result, the whole loading ballast shall consist of the specimen material, e.g. when testing contrasting colours or multicoloured material in textiles.

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6 Reagents

6.1 Reference detergents

The nominal composition of the reference detergents is given in 6.1.1 and 6.1.2. The reference detergent 6.1.1 (with optical brightener) can be used except when colour fastness is being assessed.

6.1.1 Reference detergent (with optical brightener)

Values in % are based on 100 % raw material (pure).

Nominal percentage composition by weight	Percentage
ABS-Na (C-12 chain)	0,425
Nonionic surfactant (C13/15 7EO or C12/14 7EO)	6,0
Sodium citrate dihydrate	5,0
Hydroxyethanediphosphonic acid Na salt (HEDP)	1,0
Metasilicate anhydrous	42,3
Polymer (polymaleic acid)	2,0
Foam inhibitor (phosphoric acid ester)	3,0
Sodium carbonate	39,5
Optical brightener	0,3
Remaining water from raw material	0,475
	100,00

Due to the variability which may result from the manufacturing procedure of the detergent or of its ageing, the use is recommended, for comparative measurements, of a reference detergent supplied by one definite manufacturer from a definite production batch and of recent supply. It is recommended to keep the detergent and any bleaching agent separate. It is also recommended to keep small quantities and to use it within a limited time. The reference detergent shall be stored in closed containers in a cool and dry place.

6.1.2 Reference detergent (without optical brightener)

Values in % are based on 100 % raw material (pure).

Nominal percentage composition by weight	Percentage
ABS-Na (C-12 chain)	0,425
Nonionic surfactant (C13/15 7EO or C12/14 7EO)	6,0
Sodium citrate dihydrate	5,0
Hydroxyethanediphosphonic acid Na salt (HEDT)	1,0
Metasilicate anhydrous	42,6
Polymer (polymaleic acid)	2,0
Foam inhibitor (phosphoric acid ester)	3,0
Sodium carbonate	39,5
Remaining water from raw material	0,475
	100,00

Due to the variability which may result from the manufacturing procedure of the detergent or of its ageing, the use is recommended, for comparative measurements, of a reference detergent supplied by one definite manufacturer from a definite production batch and of recent supply. It is recommended to keep the detergent and any bleaching agent separate. It is also recommended to keep small quantities and to use it within a limited time. The reference detergent shall be stored in closed containers in a cool and dry place.

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6.2 Peracetic acid bleach

The nominal composition of the standard peracetic acid bleach is as follows:

Peracetic acid: 4 % to 5 %

Hydrogen peroxide: 20 % to 30 %

The agent shall be used within 30 d of receipt.

6.3 Chlorine bleach

The nominal composition of the standard chlorine bleach is as follows:

150 g/l active chlorine (NaOCl).

Concentration needs to be checked prior to testing.

The agent shall be used within 30 d of receipt.

6.4 Hydrogen peroxide bleach

Use one of the following commonly available hydrogen peroxide solutions.

	Solution A	**Solution B**
Strength by volume (V/V)	100	130
Strength expressed as mass/volume % (m/V)	30	40
Strength expressed as mass/mass % (m/m)	27,5	35

Concentration needs to be checked prior to testing.

The agent shall be used within 30 d of receipt.

6.5 Water quality

a) hardness: $\leqslant$ 100 mg/l $CaCO_3$;

b) pH: 6,0 to 7,5;

c) content of: Fe $\leqslant$ 0,1 mg/l; Mn $\leqslant$ 0,03 mg/l; Cu $\leqslant$ 0,05 mg/l;

d) temperature: 15 °C $\pm$ 5 °C (deviations to be reported in test report).

7 Test specimen(s)

The test specimen shall be either a full garment or a composite sample. This sample shall comprise the component parts of the finished item combined in a representative assembly, particularly with regards to dimensions.

At least 3 specimens shall be subjected to the washing and drying/finishing procedures specified in this International Standard. The actual number of specimens shall be determined by the purpose for which the material is being tested.

8 Washing procedure

8.1 Select the washing procedure to be used from those given in Tables 1, 2, 3 and 4.

8.2 Condition specimens (and ballast) in accordance with ISO 139 (20 °C, 65 % relative humidity) and prepare the samples in accordance with ISO 3759, if appropriate. Determine the mass of the conditioned specimen. Place the

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test specimens to be washed in the washer/extractor (5.1) and add sufficient loading ballast (5.4) to make a load according to the size of the machine and the load ratio. Follow specifications of appropriate wash procedure selected from Table 1, 2, 3 or 4.

8.3 Use water as specified in 6.5. Add detergent and additives according to selected washing procedure.

Reference detergent 6.1.1, with optical brightener, may be used except when colour fastness is being assessed.

8.4 Acetic acid can be used in the last rinse process to adjust the pH value of the specimen. If acetic acid is used it shall be reported together with the pH value of the dried specimen (measured in accordance with ISO 3071).

8.5 After the final extraction of the washing procedure has been completed, remove the specimens, taking care that they are neither stretched nor distorted. Determine the mass of the washed specimens in order to enable calculation of moisture retention of specimens according to washing procedure. Moisture content retained of the textile shall be:

$$R = \frac{m_2 - m_1}{m_1} \times 100$$

where

R is the moisture retention of the textile, expressed as a percentage of conditioned mass;

m_1 is the mass of the conditioned textile specimens in kilograms;

m_2 is the mass of the textile specimens after extraction in kilograms.

8.6 Dry the entire load by one of the drying/finishing procedures described in clause 9.

9 Drying procedure

9.1 Procedure A — Tumble drying

Place the entire load (load ratio 1:25 to 1:35) in the tumble dryer (5.2) with the outlet temperature from the drum set not to exceed 90 °C. Operate the dryer until the load is dry, and continue tumbling for 5 min with the heat turned off (cool down). The load is dry when the final moisture content related to the conditioned specimens is 0 ± 3 %. Remove the load immediately.

9.2 Procedure B — Tunnel/cabinet finishing

Place specimens, with appropriate hangers, in the pre-heated steam cabinet (5.3). The steam cabinet shall be operated with full content and with at least one piece of ballast at the ends. The finisher shall be set at 155 °C air temperature and operating time of a minimum 4 min. When the readings of the temperature at the inlet are not automatically measured and shown on the control panel display, the ambient air temperature shall be measured with a temperature sensor in the upper part of the drying chamber. Spray steam shall be applied for between one minute and one third of the total finishing time. The load is dry when the load temperature reaches 135 °C to 140 °C. The temperature of the test specimen shall be measured using a temperature sensor at a distance of 150 mm to 200 mm from the top edge of the hanger (see annex A).

A continuous tunnel finisher may be used to provide additional information about the attributes of the specimens. Deviations from the operating conditions in 5.3 shall be reported in clause 10 e) and 10 k).

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Table 1 — Washing procedures for white workwear and/or sensitive coloured trimmings — Peracetic acid bleach

		1. Cotton	2. Polyester/cotton
	Load ratio	1:12	1:17
	Agitation during heating, washing and rinsing	normal	normal
Washing			
	Liquor ratio	1:4	1:4
	Detergents and additives	4 g/l (see 6.1.1 and 6.1.2) 2 g/l (see 6.2)	4 g/l (see 6.1.1 and 6.1.2) 2 g/l (see 6.2)
	Temperature	75 °C ± 2 °C	75 °C ± 2 °C
	Time[a]	20 min	20 min
	Cool down[b]	no	yes
	Drain	1 min	1 min
	Interspin	1 min	no
Rinse 1			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 2			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 3			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Final extraction (estimated time)	6 min	6 min
	Residual moisture	50 % to 55 %	35 % to 40 %

[a] Washing time starts when temperature is reached.

[b] Cool down: top up with cold water for 10 min in order to reduce temperature to 55 °C maximum (no more than 3 °C/min).

[c] Rinse time is measured when liquor level is reached.

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Table 2 — Washing procedures for white workwear — Chlorine bleach

		3. Cotton	4. Polyester/cotton
	Load ratio	1:12	1:17
	Agitation during heating, washing and rinsing	normal	normal
Washing			
	Liquor ratio	1:4	1:4
	Detergents	4 g/l (see 6.1.1 and 6.1.2)	4 g/l (see 6.1.1 and 6.1.2)
	Temperature	85 °C ± 2 °C	75 °C ± 2 °C
	Time[a]	20 min	20 min
	Cool down[b]	no	yes
	Drain	1 min	1 min
	Interspin	1 min	no
Rinse 1			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 2			
	Liquor ratio	1:5	1:5
	Additives (chlorine)	2 g/l (see 6.3)	2 g/l (see 6.3)
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 3			
	Liquor ratio	1:5	1:5
	Additives (antichlor)	1 g/l	1 g/l
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Final extraction (estimated time)	6 min	6 min
	Residual moisture	50 % to 55 %	35 % to 40 %

[a] Washing time starts when temperature is reached.

[b] Cool down: top up with cold water for 10 min in order to reduce temperature to 55 °C maximum (no more than 3 °C/min).

[c] Rinse time is measured when liquor level is reached.

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Table 3 — Washing procedures for white workwear and/or sensitive coloured trimmings — Hydrogen peroxide

		5. Cotton	6. Polyester/cotton
	Load ratio	1:12	1:17
	Agitation during heating, washing and rinsing	normal	normal
Washing			
	Liquor ratio	1:4	1:4
	Detergents and additives	4 g/l (see 6.1.1 and 6.1.2) 1 g/l (see 6.4)	4 g/l (see 6.1.1 and 6.1.2) 1 g/l (see 6.4)
	Temperature	85 °C ± 2 °C	85 °C ± 2 °C
	Time[a]	20 min	20 min
	Cool down[b]	no	yes
	Drain	1 min	1 min
	Interspin	1 min	no
Rinse 1			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 2			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 3			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Final extraction (estimated time)	6 min	6 min
	Residual moisture	50 % to 55 %	35 % to 40 %

[a] Washing time starts when temperature is reached.

[b] Cool down: top up with cold water for 10 min in order to reduce temperature to 55 °C maximum (no more than 3 °C/min).

[c] Rinse time is measured when liquor level is reached.

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Table 4 — Washing procedures for coloured workwear

		7. Cotton	8. Polyester/cotton
	Load ratio	1:12	1:17
	Agitation during heating, washing and rinsing	normal	normal
Washing			
	Liquor ratio	1:4	1:4
	Detergents	5 g/l (see 6.1.1 and 6.1.2)	5 g/l (see 6.1.1 and 6.1.2)
	Temperature	85 °C ± 2 °C	75 °C ± 2 °C
	Time[a]	20 min	20 min
	Cool down[b]	no	yes
	Drain	1 min	1 min
	Interspin	1 min	no
Rinse 1			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 2			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Interspin	1 min	1 min
Rinse 3			
	Liquor ratio	1:5	1:5
	Time[c]	3 min	3 min
	Drain	1 min	1 min
	Final extraction (estimated time)	6 min	6 min
	Residual moisture	50 % to 55 %	35 % to 40 %

[a] Washing time starts when temperature is reached.

[b] Cool down: top up with cold water for 10 min in order to reduce temperature to 55 °C maximum (no more than 3 °C/min).

[c] Rinse time is measured when liquor level is reached.

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10 Test report

The test report shall contain the following information.

a) name of testing authority and report identification;

b) date of testing;

c) reference to this International Standard, i.e. ISO 15797;

d) identification and description of the specimens to be tested;

e) type of machine according to 5.1, 5.2 and 5.3 and the washing and drying/finishing procedures used;

f) total number of washing and drying/finishing procedures conducted on the specimens;

g) type and concentration of detergent/optical brightener (6.1) and additives (6.2, 6.3, 6.4) used;

h) if acetic acid is used in the last rinse, the concentration of acetic acid used and pH value of dried specimens;

i) total mass of the specimens and loading ballast and type of loading ballast (5.4);

j) settings/programmed temperatures for drying;

k) details of any deviation from the specified procedures.

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Annex A
(normative)

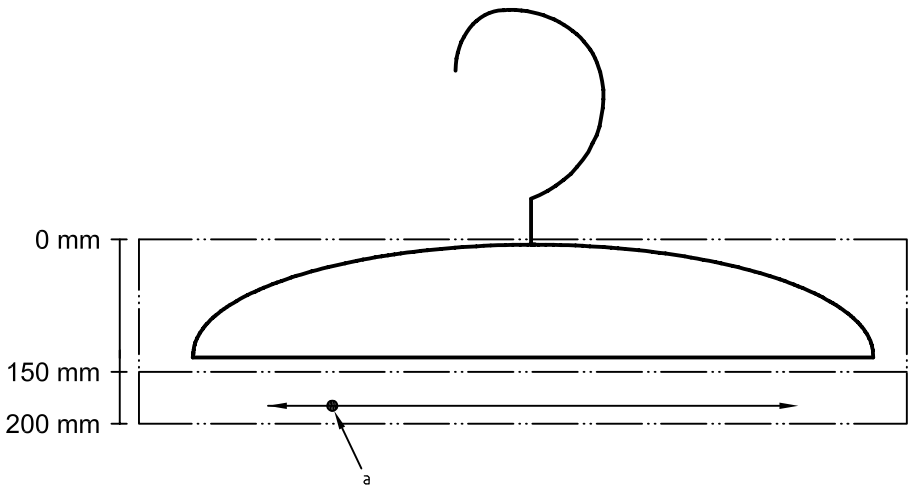
Additional information for procedure B — Tunnel/cabinet finish

Place the temperature sensor bead on the test specimen surface at a distance of 150 mm to 200 mm from the top edge of the hanger (see Figure A.1).

The temperature sensor shall be fixed on the specimen surface, ensuring correct measurements by shielding it from ambient air stream temperature (see Figure A.2). Fixing could be made with suitable adhesive tape, two stitches or appropriate clips. The temperature sensor bead shall be placed close to the specimen surface in the cool boundary phase (see Figure A.3).

When temperature strips are used, a calibration cycle per load should be made to adjust the suitable drying time.

In case certain zones on a specimen are to be tested (e.g. seams), the temperature shall also be determined at these areas.



[a] Temperature measurement

Figure A.1 — Position of temperature sensor on test specimen

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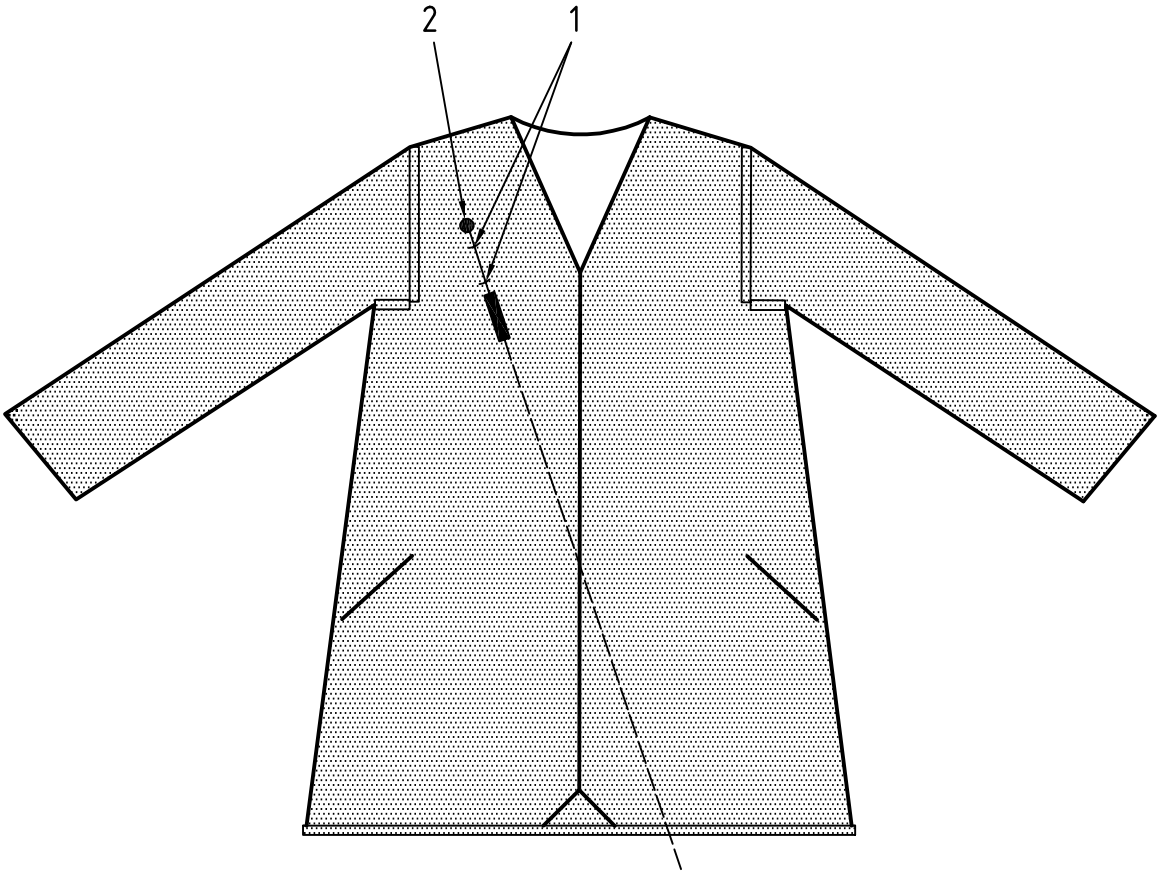

Key

1 Stitches for fixing

2 Temperature sensor bead

Figure A.2 — Fixing of temperature sensor on test specimen (front view)

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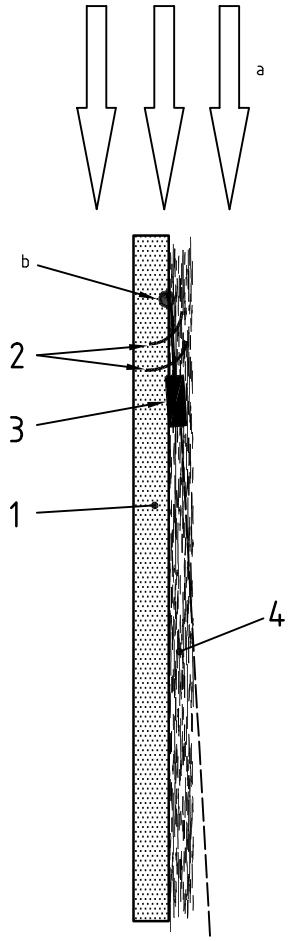

Key

1 Damp test specimen
2 Stitches for fixing
3 Connecting plug
4 Cool boundary phase

[a] Hot air stream

[b] Temperature sensor bead

Figure A.3 — Fixing of temperature sensor on test specimen (side view)

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