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Textiles — Determination of deodorant property —

Part 5: Metal-oxide semiconductor sensor method

Textiles — Détermination de la propriété de déodorant —

Partie 5: Méthode par capteur à semi-conducteur métal-oxyde

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 38, *Textiles*.

ISO 17299 consists of the following parts, under the general title *Textiles — Determination of deodorant property*:

— *Part 1: General principle*

— *Part 2: Detector tube method*

— *Part 3: Gas chromatography method*

— *Part 4: Condensation sampling analysis*

— *Part 5: Metal-oxide semiconductor sensor method*

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Introduction

This part of ISO 17299 describes a test method using a testing instrument equipped with multiple metal-oxide semiconductor sensors against composite odours for all textiles. The multiple sensors improve accuracy for several kinds of composite odours.

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Textiles — Determination of deodorant property —

Part 5:
Metal-oxide semiconductor sensor method

1 Scope

This part of ISO 17299 specifies a deodorant test method using an odour analyser equipped with multiple metal-oxide semiconductor sensors against composite odours. The artificial composite odours used in this part of ISO 17299 are a quasi sweat odour, a quasi body odour (nonenal mixture odour) and a quasi excrement odour.

This part of ISO 17299 applies to all kinds of textile products, such as woven fabrics, knits, threads, yarns, fibres, braids, cords, etc.

2 Normative references

ISO 17299-1, *Textiles — Determination of deodorant property — Part 1: General principle*

3 Terms and definitions

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

3.1
quasi unpleasant odour
artificial composite odour used to simulate an unpleasant odour

Note 1 to entry: Artificial composite odours for the purpose of this part of ISO 17299 are as follows:

— quasi sweat odour: ammonia, acetic acid, isovaleric acid;

— quasi body odour (nonenal mixture odour): ammonia, acetic acid, isovaleric acid, nonenal;

— quasi excrement odour: ammonia, acetic acid, hydrogen sulfide, methyl mercaptan, indole.

3.2
odour unit concentration
concentration defined as the rate of the odour chemical concentration in µl/l against the olfactory threshold concentration

Note 1 to entry: It is expressed in OU/m^3.

3.3
olfactory threshold concentration
minimum concentration at which human could perceive

Note 1 to entry: Olfactory threshold concentration value of the odour chemical substances used in this part of ISO 17299 is shown in Table 1.

Note 2 to entry: See Reference [1] in the Bibliography.

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Table 1 — Olfactory threshold concentration

Unpleasant odour components	Ammonia	Acetic acid	Isovaleric aicid	Nonenal	Hydrogen sulfide	Methyl mercaptan	Indole
Olfactory threshold concentration [µl/l]	1,5	0,006	0,000 078	0,000 08	0,000 41	0,000 07	0,000 3

3.4
metal-oxide semiconductor sensor
sensor using a metal-oxide semiconductor made of e.g. tin dioxide

Note 1 to entry: The response of sensors corresponds to gas chemical concentration. The blend recipe of the constituent metal-oxide gives different response trend to chemicals.

3.5
odour test instrument
instrument equipped with multiple metal-oxide semiconductor sensors

Note 1 to entry: This instrument is built up with the inlet of the testing gas, sensors, and cleaning system of sensor head.

3.6
response value
value obtained as outputs from sensors

3.7
response vector
vector for a quasi unpleasant odour consisting of response value obtained from each sensor separately

3.8
response vector length
length obtained as vector sum which is calculated as square-root of sum of squares of response values

Note 1 to entry: The length represents a proportional amount of chemical concentration.

3.9
calibration curve
curve that determines odour unit concentration corresponding to response vector length

Note 1 to entry: The quadratic curve is used for this calibration curve derived from Reference [2] as proximity.

4 Principle

The quasi unpleasant odour gas is inserted in plastic bags with test specimen or without specimen. After 2 h reaction time, the odour unit concentration of remained gases is obtained by using an odour test instrument with 10 metal-oxide semiconductor sensors. The reduction rate in odour chemical concentration is calculated from the odour unit concentration with and without specimen.

5 Reagents

Unless otherwise specified, analytical grade reagents shall be used in this test.

5.1 **Ammonia water**, reagent of 28 % in concentration of ammonia (NH_3) in water.

5.2 **Acetic acid**, reagent of 99,7 % in concentration of acetic acid (CH_3COOH) in water.

5.3 **Methyl mercaptan**, 100 µl/l in concentration of standard gas by nitrogen dilution.

5.4 **Hydrogen sulfide**, 100 µl/l in concentration of standard gas by nitrogen dilution.

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5.5 **Indole**, indole (C_8H_7N) reagent.

5.6 **Isovaleric acid**, 98,0 % solution.

5.7 **Nonenal**, 2-nonenal ($C_9H_{16}O$) reagent (95,0 % solution).

5.8 **Diluent gas**, dry air obtained from nitrogen - oxygen mixture cylinder with purity of at least 99,999 9 % or, nitrogen gas from nitrogen gas cylinder with purity of at least 99,999 9 %.

6 Apparatus and materials

Unless otherwise specified, the following shall be used in this test.

6.1 **Plastic bag**, 3 l in capacity with a glass tube as inlet of gas.

6.2 **Air pump**, with a flow meter or an integrating flow meter for 3 l/min flow rate.

6.3 **Oven**, capable of operating at 80 °C.

6.4 **Micro-syringe**, with a capacity of 10 µl.

6.5 **Syringe**, with a capacity of 200 ml.

6.6 **Detector tube**, with a concentration measurement range of 50 µl/l to 500 µl/l for ammonia.

6.7 **Heat seal**, capable of sealing a plastic bag.

6.8 **Aspirator** or **vacuum pump**.

6.9 **Odour test instrument**, with 10 metal-oxide semiconductor sensors.

7 Preparation of the odour test gas

The odour test gases are prepared just before the test. Master gases and the quasi unpleasant odours may be prepared by permeator or gas cylinder.

7.1 Master gas

7.1.1 Clean 3 l of plastic bags (6.1) by using the diluent gas, then the preparation of master gases of odour component chemicals is as described in 7.1.2 to 7.1.4.

7.1.2 Ammonia, acetic acid, isovaleric acid, and nonenal

7.1.2.1 Inject 2,5 l of the diluent gas into the plastic bags (7.1.1).

7.1.2.2 Inject the chemical solution with the amount according to Table 2 into plastic bags prepared in 7.1.2.1.

7.1.2.3 Keep the plastic bags with the prepared gas under the test environment for 30 min.

7.1.3 Hydrogen sulfide and methyl mercaptan

7.1.3.1 Inject the chemical standard gases with the amount according to Table 2 into plastic bags.

7.1.4 Indole

7.1.4.1 Put the specified amount of indole powder into a plastic bag (6.1) according to Table 2.

7.1.4.2 Inject 2,5 l of dilute gas in the plastic bag.

7.1.4.3 Heat the plastic bag for sublimation at 80 °C for 10 min.

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7.1.4.4 Transfer all gas of 7.1.4.3 to new plastic bag.

Table 2 — Master gas concentration of unpleasant odour components and manufacture method

Master gas	Ammonia	Acetic acid	Isovaleric acid	Nonenal	Hydrogen sulfide	Methyl mercaptan	Indole
Master gas target concentration [µl/l]	1 500	500	50	15	100	100	6
Diluent gas quantity [ml]	2 500	2 500	2 500	2 500	0	0	2 500
Materials of odour components chemicals	Ammonia water (5.1)	Acetic acid (5.2)	Isovaleric acid (5.6)	Nonenal (5.7)	Hydrogen sulfide (5.4)	Methyl mercaptan (5.3)	Indole reagent (5.5)
Quantity of injection odour component chemicals	10 µl	5 µl	2 µl	5 µl	2 500 ml	2 500 ml	0,3 g powder
Inspection	Dilute to 1/10 and use detector tube	No action					

7.2 Preparation of the test quasi unpleasant odours

The compositions of the quasi unpleasant odours are shown in Table 3. The compositions give the initial concentration of odour chemicals for test.

Table 3 — Composition of chemicals in the quasi unpleasant odours

Unpleasant odour components		Composition of chemicals for master gas (ml)								Total (ml)
		Ammonia	Acetic acid	Isovaleric acid	Nonenal	Hydrogen sulfide	Methyl mercaptan	Indole	Diluent gas	
Quasi unpleasant odour	Sweat odour	50	250	500	-	-	-	-	1 700	2 500
	Body odour (nonenal mixture odour)	50	250	500	830	-	-	-	870	2 500
	Excrement odour	50	250	-	-	100	200	1 250	650	2 500
Initial concentration of components [µl/l]		30	50	10	5	4	8	3		

7.2.1 Preparation of the quasi sweat odour

7.2.1.1 Clean a plastic bag (6.1) by using the diluent gas (5.8).

7.2.1.2 Inject 1,7 l of the diluent gas into the plastic bag by using the air pump (6.2).

7.2.1.3 Inject 500 ml of isovaleric acid master gas, 250 ml of acetic acid master gas and 50 ml of ammonia master gas in order into the plastic bag by using the syringe (6.5) according to Table 3. See Figure 1.

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Figure 1 — Injection of master gases

7.2.2 Preparation of quasi body odour (nonenal mixture odour)

7.2.2.1 Clean a plastic bag (6.1) by using the diluent gas (5.8).

7.2.2.2 Inject 870 ml of the diluent gas into the plastic bag by using the air pump (6.2).

7.2.2.3 Inject 830 ml of nonenal master gas, 500 ml of isovaleric acid master gas, 250 ml of acetic acid master gas and 50 ml of ammonia master gas in order into the plastic bag by using syringe (6.5) according to Table 3.

7.2.3 Preparation of quasi excrement odour

7.2.3.1 Clean a plastic bag (6.1) by using the diluent gas (5.8).

7.2.3.2 Inject 650 ml of the diluent gas into the plastic bag by using the air pump (5.2).

7.2.3.3 Inject 1 250 ml of indole master gas, 200 ml of methyl mercaptan master gas, 100 ml of hydrogen sulfide master gas, 250 ml of acetic acid master gas and 50 ml of ammonia master gas in order into the plastic bag by using syringe (6.5) according to Table 3.

8 Sensor response check

To confirm the response of the sensors, the measurements are performed with all odour chemicals by using the odour test instrument (6.9).

If a sensor shows no response, replace the sensor and check again.

9 Preparation of calibration curve

9.1 Initial concentration

The initial odour chemical concentrations of the test are shown in Table 3 for all component chemicals.

9.2 Odour unit concentration for quasi unpleasant odours

9.2.1 Odour unit concentration for the initial concentration

The odour unit concentration value is simply calculated by the initial concentration (b) divided by the olfactory threshold concentration (a) as shown in Table 4.

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Table 4 — Odour unit concentration for the component chemicals

Unpleasant odour components	Ammonia	Acetic acid	Isovaleric aicid	Nonenal	Hydrogen sulfide	Methyl mercaptan	Indole
Olfactory threshold concentration [µl/l] (a)	1,5	0,006	0,000 078	0,000 08	0,000 41	0,000 07	0,000 3
Initial concentration of components [µl/l] (b)	30	50	10	5	4	8	3
Odour unit concentration (b)/(a)	20	8 333	128 205	62 500	9 756	114 286	10 000

9.2.2 Odour unit concentration for the quasi unpleasant odour

The largest odour unit concentration value of the component chemicals is selected as the odour unit concentration of the quasi unpleasant odour as shown in Table 5.

Table 5 — Odour unit concentration of the quasi unpleasant odours

Quasi unpleasant odour	Odour unit concentration for selection							
	quasi unpleasant odours	Ammonia	Acetic acid	Isovaleric acid	Nonenal	Hydrogen sulfide	Methyl mercaptan	Indole
Sweat odour	**128 205**	20	8 333	**128 205**				
Body odour (nonenal mixture odour)	**128 205**	20	8 333	**128 205**	62 500			
Excrement odour	**114 286**	20	8 333			9 756	**114 286**	10 000

9.3 Creation of calibration curve for quasi unpleasant odours

9.3.1 Preparation of dilution series

9.3.1.1 Clean 3 l of the plastic bags by using diluent gas.

9.3.1.2 Inject the master gas and diluent gas with the amount shown in Table 6 by using the air pump into the plastic bags.

Table 6 — Mixing recipe for dilution series

Dilution series	master gas (ml)	diluent gas (ml)	Total (ml)
Initial concentration	2 500	0	2 500
1/3	830	1 670	
1/10	250	2 250	
1/100	25	2 475	

9.3.2 Measurement

Obtain the response values for dilution series of all quasi unpleasant odours by using the odour test instrument.

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9.3.3 Calibration curves

9.3.3.1 Calculate the response vector length by square-root of sum of squares from all response values for all dilution series.

9.3.3.2 Obtain the calibration curves of quadratic approximation between the calculated vector lengths and the odour unit concentrations. An example is shown in Annex A.

NOTE Because of a quadratic curve, the differential equation of the calibration equation gives the specific response vector length value for the minimum odour unit concentration at zero. To validate this test, the obtained vector length from the test may be larger than the specific vector length value.

10 Deodorant test

10.1 Preparation of test specimen

The dimension or mass of test specimens is shown in Table 7.

Table 7 — Dimension or mass of test specimens

Type	Dimension or mass
Cloth (woven, knitted, non-woven and tape)	100 cm^2 ± 5 cm^2
Yarn, fibre and feather	1,0 g ± 0,05 g

In case of products consisting of multi-layers, it is recommended to cover the parts not intended for this test by aluminium foil in order to avoid any unintended effect. The specimen can be folded in half so as to place the part not intended for test inside.

10.2 Conditioning of the specimen

Condition the specimen as specified in ISO 17299-1.

10.3 Test procedure

10.3.1 Preparation of plastic bags

Prepare six plastic bags (6.1), three plastic bags for the test with specimen and three plastic bags for the test without specimen and clean the plastic bags by using diluent gas before testing.

10.3.2 Insertion of specimen

Place the test specimen in three plastic bags one by one so as to spread as much as possible.

In case the specimen is curled, smooth the specimen as much as possible.

10.3.3 Removal of air from the plastic bags

Remove any remaining air from the plastic bags with specimen after heat seal by using the inlet of plastic bags as much as possible. To do so, place the specimen near the inlet to make easy removal of air.

10.3.4 Injection of testing gas

Inject 2 500 ml of the testing gas i.e. the quasi unpleasant odour into the plastic bag with and without specimen. See Figure 2.

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Figure 2 — After injection of quasi unpleasant odour gas in plastic bags with or without specimen

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10.3.5 Reaction time

Place the testing plastic bags for 2 h after injection of test gas.

10.3.6 Measurement by using the odour test instrument

Measure the test gas after the reaction time of 2 h by using the odour test instrument for both the test gases with and without specimen. Carry out three measurements for both the test gases with and without specimen.

11 Calculation of the odour unit concentration

11.1 Calculate the vector lengths for all tests by the square root of sum of squares from the all sensor response values.

11.2 Average three calculated vector lengths for both test gases with and without specimen respectively.

11.3 Calculate the odour unit concentration from the calibration curve.

11.4 The odour unit concentration of the test gas without specimen is denoted by B and with specimen is denoted by A.

12 Calculation of reduction rate

Calculate the reduction rate of quasi unpleasant odour by using the following equation:

$$ORR = \frac{(B - A)}{B} \times 100$$

where

ORR is the reduction rate of quasi unpleasant odour in percentage;

B is the odour unit concentration of the test gas without specimen;

A is the odour unit concentration of test gas with specimen.

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13 Test report

The following items are at least recorded in the test report:

a) a reference to this part of ISO 17299 (i.e. ISO 17299-5);

b) details of the sample for test;

c) name of quasi unpleasant odour;

d) reduction rate;

e) any deviation from this part of ISO 17299.

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Annex A
(informative)

Example of the test

A.1 General

This is an example of the deodorant test using the quasi sweat odour according to this part of ISO 17299.

A.2 Test sample

— deodorant treatment; sweat odour deodorant chemicals,

— material: polyester,

— structure: plain woven fabric, tropical,

— mass: 158 g/m^2.

A.3 Quasi unpleasant odour

Quasi sweat odour. Prepared as specified in 7.2.1.

A.4 Odour test instrument

The odour test instrument with 10 metal-oxide semiconductor sensors was used.

A.5 Sensor response check

The sensor response check was done for component chemicals at the initial concentration of the quasi sweat odour individually.

The response of all sensors was confirmed as appropriate as shown in Table A.1.

Table A.1 — Response check for all component chemicals of the quasi sweat odour

Odour component chemicals	Concentration [µl/l]	Response data of each sensors										Response vector length
		CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	
Ammonia	30	0,290	0,802	0,417	0,190	0,368	0,616	0,269	0,386	0,243	0,820	1,551
Acetic acid	50	0,381	0,887	0,793	0,172	0,689	0,806	0,931	0,818	0,423	1,010	2,334
Isovaleric acid	10	0,275	0,470	0,637	0,105	0,551	0,541	0,624	0,533	0,365	0,588	1,569

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A.6 Calibration curves preparation

A.6.1 Odour unit concentration of the quasi sweat odour

The odour unit concentration of quasi sweat odour is determined as in Table 5 as an initial concentration. So, the odour unit concentrations for the dilution are given in Table A.2. The calculation of the odour unit concentrations is simple as the initial value multiplied by the dilution rate.

Table A.2 — Odour unit concentration for the quasi sweat odour

Unpleasant odour components		Quasi sweat odour
Odour unit concentration [µl/l]	Initial	128 205
	1/3 dilution	42 735
	1/10 dilution	12 820
	1/100 dilution	1 282

A.6.2 Test for the calibration curve

The test to create the calibration curves was carried out according to 9.3.

Table A.3 — Response data for the quasi sweat odour dilution series

Quasi sweat odour	Response value from each sensor									
	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10
Initial	0,385	1,058	0,698	0,235	0,602	0,824	0,830	0,833	0,390	1,115
1/3 dilution	0,277	0,562	0,474	0,144	0,352	0,617	0,520	0,519	0,317	0,647
1/10 dilution	0,229	0,367	0,235	0,126	0,171	0,543	0,277	0,324	0,230	0,424
1/100 dilution	0,207	0,317	0,082	0,122	0,057	0,524	0,151	0,221	0,162	0,351

A.6.3 Creation of the calibration curves

A.6.3.1 Calculation of the response vector length

The calibration curve is to obtain the relationship between response vector length and odour unit concentration.

The response vector length is calculated from data in Table A.3 using Formula (A.1). The result is shown in Table A.4 with the odour unit concentration from Table A.2.

$$Z = \sqrt{(CH1)^2 + (CH2)^2 + (CH3)^2 + (CH4)^2 + (CH5)^2 + (CH6)^2 + (CH7)^2 + (CH8)^2 + (CH9)^2 + (CH10)^2} \quad \text{(A.1)}$$

where

Z is the response vector length;

$CH1$ to $CH10$ is the response value from each sensor.

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Table A.4 — Calculated vector lengths for the quasi sweat odour

Quasi sweat odour	Odour unit concentration	Response vector length
Initial	128 205	2,373
1/3 dilution	42 735	1,484
1/10 dilution	12 820	0,998
1/100 dilution	1 282	0,815

A.6.3.2 Calibration curve

The calibration curve (see Figure A.1) is calculated by using proper statistic calculation soft with the quadratic approximation as follows.

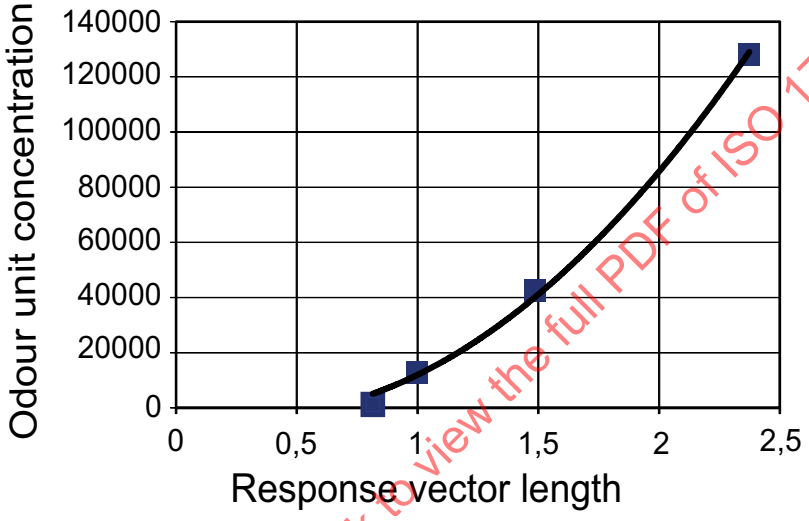

Figure A.1 — Calibration curve of quasi sweat odour

The calibration Formula (A.2) obtained here is as follows:

$$Y = 30\,849X^2 - 18\,846X \tag{A.2}$$

where

Y is an odour unit concentration;

X is a response vector length.

The specific response vector length at the minimum of the odour unit concentration is given by the differential equation as follows:

$$\frac{dY}{dX} = 2\times 30\ \ 849X - 18\ \ 846 = 0\text{ , then }\frac{18\ \ 846}{61\ \ 698} = 0{,}305 \tag{A.3}$$

NOTE This value was referred to the test value.

A.7 Deodorant test

The deodorant test was performed according to Clause 10. The ten response values for the test with and without specimen were obtained and vector lengths were calculated as shown in Table A.5.

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Table A.5 — Result of deodorant test without specimen and response vector length

Deodorant test	Response data of each sensors										Response vector length
	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	
Without specimen	0,364	0,923	0,662	0,196	0,563	0,744	0,788	0,756	0,380	0,989	2,156
With specimen	0,232	0,407	0,277	0,125	0,202	0,534	0,308	0,356	0,236	0,455	1,059

The minimum value is 1,059 which is much higher than 0,305, so the calibration curve is validated for use.

A.8 Test results

A.8.1 Calculation for odour unit concentration

A.8.1.1 Calculation of the odour unit concentration using the calibration Formula (A.2). The result is shown in Table A.6.

Table A.6 — Calculation process of the odour unit concentration

Deodorant test result	X	X^2	Y
	Response vector length		Odour unit concentration
With specimen	1,059	1,121	14 638 (A)
Without specimen	2,156	4,644	102 650 (B)

A.8.1.2 Calculation of the reduction rate (ORR) % from the following equation:

$$ORR = \frac{(B - A)}{B} \times 100 \quad \text{(A.4)}$$

According to Formula (A.4), the reduction rare of the quasi unpleasant odour for this deodorant textile sample is calculated as follows:

$$ORR = \frac{(102\,650 - 14\,638)}{102\,650} \times 100 = 85,7$$

The reduction rate is 85,7 %.

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Annex B
(informative)

Specifications of the odour test instrument

B.1 Odour test instrument specification

B.1.1 Sampling

— Feed rate for sampling: 165 ml/min

— Measuring time (main unit): 2 min

B.1.2 Specification of the test instrument

Table B.1 — Specification of the odour test instrument

Odour test instrument	Flavour and flagrance analyser
Odour sensor	Metal-oxide semiconductor
Number of sensors	10 with different metal-oxide composition
Temperature and humidity at sensor cell	75 °C, 0 % RH
Sensor cleaning	Nitrogen flow
Carrier gas	Nitrogen: 99,999 9 % AIR:G1 grade (CO < 0,1 µl/l, CO_2 < 0,1 µl/l, CH_4 < 0,1 µl/l, NO_X < 0,01 µl/l, SO_2 < 0,01 µl/l, H_2O (dew point) < 80 °C)
Operating temperature limit	15 °C to 30 °C ambient temperature
Temperature fluctuation limit during measurement	±2 °C (ambient temperature)

B.2 Reason for using 10 sensors

B.2.1 Sensor response property

As shown in Figure A.1 the response of these sensors is not linear and each sensor shows different sensitivity for odour chemicals. Table B.2 shows the response sensitivity of each sensor to each odour chemical.

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Table B.2 — Sensor response sensitivity to each chemical

Sensor CH No.	Odour component							Quasi unpleasant odour		
	Ammo-nia	Acetic acid	Isovaleric acid	Hydrogen sulfide	Methyl mercaptan	Indole	Non-enal	Body odour (nonenal mixture odour)	Sweat odour	Excre-ment odour
1					○	○				
2	○							○		
3			○		○				○	○
4	○									
5			○		○					
6	○	○					○	○		
7			○		○					
8					○					○
9			○	○	○				○	
10	○							○		

The sensors with the different composition of metal-dioxide have specific sensitivity for specific chemicals as shown in Table B.2. This instrument comprises 10 different sensors to work together complementarily, reducing the effect of the sensitivity change due to deterioration by periodical use or age. The deterioration effect is different to sensors and difficult to speculate for each sensor. When using 10 sensors, the supplier has a confidence to reduce the variation from the condition change of the sensors.

B.2.2 Sensitivity variation by number of sensors

The sensitivity of sensors is defined as a difference in response value divided by a difference in chemical concentration. The deviation in sensitivity is calculated as (maximum difference in sensitivity – minimum difference in sensitivity) divided by maximum difference in sensitivity and for all sensors and combination of sensors, i.e. 1 023 cases. The average and variation of the deviation of sensitivity are plotted in Figure B.1. The variation of sensitivity decreases when the number of sensors increases.

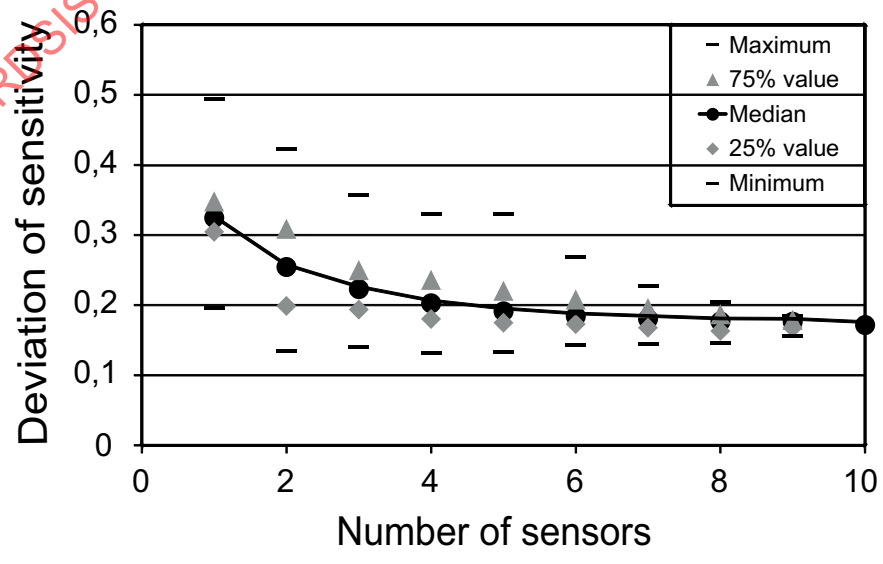

Figure B.1 — Variation for deviation of sensitivity depending on the number of sensors

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However, any other instruments with less metal-oxide sensors likely to be available may also be used for this testing method after proper validation.

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Annex C
(informative)

Practical testing results

C.1 General

The tests according to this part of ISO 17299 are performed on quasi sweet odour, quasi body odour (nonenal mixture odour) and quasi excrement odour.

C.2 Test sample

C.2.1 Polyester woven fabric

C.2.2 Test A; Quasi sweat odour

— A-1; Untreated fabric

— A-2; Deodorant treated fabric for quasi sweat odour

C.2.3 Test B; Quasi body odour (nonenal mixture odour)

— B-1; Untreated fabric

— B-2; Deodorant treated fabric for quasi body odour (nonenal mixture odour)

C.2.4 Test C; Quasi excrement odour

— C-1; Untreated fabric

— C-2; Deodorant treated fabric for quasi excrement odour

C.3 Test result

C.3.1 Test A

C.3.1.1 Calibration curve

Table C.1 — Calibration equation

Test date	Calibration equation
Day 1	$Y = 25\,373X^2 - 5\,716{,}8X$
Day 2	$Y = 31\,917X^2 - 18\,006X$
Day 3	$Y = 27\,066X^2 - 13\,040X$
Day 4	$Y = 29\,411X^2 - 15\,860X$

C.3.1.2 Evaluated response vector length without specimen

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Table C.2 — Response vector values for quasi sweat odour without specimen

Test date	Vector values without specimen				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	2,240	2,341	2,434	2,338	0,009 414
Day 2	2,309	2,212	2,229	2,250	0,002 683
Day 3	2,371	2,375	2,395	2,380	0,000 165
Day 4	2,298	2,298	2,301	2,299	0,000 003

C.3.1.3 Evaluated response vector length with specimens

Table C.3 — Response vector values for quasi sweat odour with specimen A-1

Test date	Vector values with specimen A-1				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	1,963	1,979	1,991	1,978	0,000 197
Day 2	1,867	1,834	1,813	1,838	0,000 741
Day 3	2,063	1,996	2,037	2,032	0,001 141
Day 4	1,997	1,943	1,952	1,964	0,000 837

Table C.4 — Response vector values for quasi sweat odour with specimen A-2

Test date	Vector values with specimen A-2				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	0,861	0,904	0,885	0,883	0,000 464
Day 2	1,085	1,143	1,269	1,166	0,008 849
Day 3	0,851	0,872	0,867	0,863	0,000 120
Day 4	0,817	0,834	0,832	0,828	0,000 086

C.3.1.4 Evaluated odour unit concentration without specimen

ORR % is the reduction rate which is calculated by using data from Table C.5, Table C.6 and Table C.7.

Table C.5 — Odour unit concentration for quasi sweat odour without specimen

Test date	Odour unit concentration without specimen				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	114 506	125 668	136 404	125 526	119 896 415
Day 2	128 589	116 339	118 442	121 123	42 907 869
Day 3	121 237	121 699	124 020	122 319	2 224 400
Day 4	118 867	118 867	119 226	118 987	42 770
Mean				121 989	
Repeatability variance (average)					41 267 863
Variance on the test date difference					7 460 544
STD of repeatability					6 424
STD on the test date difference					2 731
CV % of repeatability					5,3 %
CV % on the test date difference					2,2 %

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C.3.1.5 Evaluated odour unit concentration with specimens

Table C.6 — Odour unit concentration for quasi sweat odour with specimen A-1 and *ORR* %

Test date	Odour unit concentration with specimen A-1					
	n = 1	*n* = 2	*n* = 3	Mean	Variance	*ORR* %
Day 1	86 549	88 058	89 198	87 935	1 765 661	29,9 %
Day 2	77 636	74 332	72 265	74 744	7 337 464	38,3 %
Day 3	88 291	81 804	85 744	85 279	10 682 370	30,3 %
Day 4	85 619	80 218	81 106	82 314	8 387 582	30,8 %
Mean				82 568		32,3 %
Repeatability variance (average)					7 043 269	
Variance on the test date difference					32 479 386	0,001 590
STD of repeatability					2 654	
STD on the test date difference					5 699	4,0 %
CV % of repeatability					3,2 %	
CV % on the test date difference					6,9 %	12,3 %

Table C.7 — Odour unit concentration for quasi sweat odour with specimen A-2 and *ORR* %

Test date	Odour unit concentration with specimen A-2					
	n = 1	*n* = 2	*n* = 3	Mean	Variance	*ORR* %
Day 1	13 887	15 567	14 813	14 756	707 954	88,2 %
Day 2	18 037	21 117	28 548	22 567	29 199 524	81,4 %
Day 3	8 504	9 210	9 040	8 918	135 544	92,7 %
Day 4	6 674	7 230	7 163	7 022	92 177	94,1 %
Mean				13 316		89,1 %
Repeatability variance (average)					7 533 800	
Variance on the test date difference					48 872 228	0,003 284
STD of repeatability					2 745	
STD on the test date difference					6 991	5,7 %
CV % of repeatability					20,6 %	
CV % on the test date difference					52,5 %	6,4 %

C.3.2 Quasi body odour (nonenal mixture odour)

C.3.2.1 Calibration curves

Table C.8 — Calibration equation of each test date

Test date	Calibration equation
Day 1	$Y = 32\,189\,X^2 - 15\,955\,X$
Day 2	$Y = 32589\,X^2 - 16\,718\,X$
Day 3	$Y = 32\,147\,X^2 - 20\,331\,X$
Day 4	$Y = 26\,080\,X^2 - 7\,536{,}5\,X$

C.3.2.2 Evaluated response vector length without specimen

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Table C.9 — Response vector values for quasi body odour (nonenal mixture odour) without specimen

Test date	Vector values without specimen				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	2,163	2,210	2,205	2,193	0,000 666
Day 2	2,155	2,185	2,230	2,190	0,001 425
Day 3	2,316	2,339	2,260	2,305	0,001 651
Day 4	2,374	2,358	2,289	2,340	0,002 040

C.3.2.3 Evaluated response vector length with specimens

Table C.10 — Response vector values for quasi body odour (nonenal mixture odour) with specimen B-1

Test date	Vector values with specimen B-1				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	1,923	1,884	1,867	1,891	0,000 824
Day 2	1,893	1,887	1,898	1,893	0,000 030
Day 3	1,856	1,871	1,878	1,868	0,000 126
Day 4	1,937	1,916	1,947	1,933	0,000 250

Table C.11 — Response vector values for quasi body odour (nonenal mixture odour) with specimen B-2

Test date	Vector values with specimen B-2				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	0,912	0,882	0,912	0,902	0,000 300
Day 2	1,040	0,912	1,040	0,997	0,005 461
Day 3	0,967	1,010	1,077	1,018	0,003 073
Day 4	0,929	0,954	0,905	0,929	0,000 600

C.3.2.4 Evaluated odour unit concentration without specimen

ORR % is the reduction rate which is calculated by using data from Table C.12, Table C.13 and Table C.14.

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Table C.12 — Odour unit concentration for quasi body odour (nonenal mixture odour) without specimen

Test date	Odour unit concentration without specimen				
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance
Day 1	116 088	121 954	121 323	119 788	10 369 025
Day 2	115 317	119 058	124 781	119 719	22 718 101
Day 3	125 345	128 319	118 246	123 970	26 787 059
Day 4	129 092	127 238	119 396	125 242	26 493 110
Mean				122 180	
Repeatability variance (average)					21 591 824
Variance on the test date difference					8 119 766
STD of repeatability					4 647
STD on the test date difference					2 850
CV % of repeatability					3,8 %
CV % on the test date difference					2,3 %

C.3.2.5 Evaluated odour unit concentration with specimens

Table C.13 — Odour unit concentration for quasi body odour (nonenal mixture odour) with specimen B-1 and *ORR* %

Test date	Odour unit concentration with specimen B-1					
	$n = 1$	$n = 2$	$n = 3$	Mean	Variance	*ORR* %
Day 1	88 351	84 194	82 413	84 986	9 286 178	29,1 %
Day 2	85 134	84 495	85 668	85 099	344 863	28,9 %
Day 3	73 004	74 496	75 197	74 232	1 255 020	40,1 %
Day 4	83 253	81 301	84 191	82 915	2 173 085	33,8 %
Mean				81 808		33,0 %
Repeatability variance (average)					3 264 786	
Variance on the test date difference					26 516 418	0,002 786
STD of repeatability					1 807	
STD on the test date difference					5 149	5,3 %
CV% of repeatability					2,2 %	
CV% on the test date difference					6,3 %	16,0 %

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