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Cigarettes — Determination of ventilation — Definitions and measurement principles

Cigarettes — Détermination du taux de ventilation — Définitions et principes de mesurage

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 126, *Tobacco and tobacco products* Subcommittee SC 1, *Physical and dimensional tests*.

This third edition cancels and replaces the second edition (ISO 9512:2002), which has been technically revised. The main changes compared to the previous edition are as follows:

— introduction of the prime designator (Q') to indicate a component of the ventilation flow that is measured on the inlet side to the cigarette or standard and that is converted to a volumetric flow at the outlet side (see 3.5);

— addition of a typical calibration process for ventilation standards (see A.3.2 j);

— updated product repeatability and reproducibility statistics (see Clause 11);

— editorial changes in accordance with current guidelines.

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.

Cigarettes — Determination of ventilation — Definitions and measurement principles

1 Scope

This document specifies a method for the determination of ventilation which is applicable to cigarettes.

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 3308, *Routine analytical cigarette-smoking machine — Definitions and standard conditions*

ISO 3402:1999, *Tobacco and tobacco products — Atmosphere for conditioning and testing*

ISO 6565, *Tobacco and tobacco products — Draw resistance of cigarettes and pressure drop of filter rods — Standard conditions and measurement*

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 http://www.electropedia.org/

3.1
ventilation
aspiration of atmospheric air into an unlit cigarette other than through its *front area* (3.2)

Note 1 to entry: Dilution is the effect of ventilation on the smoke concentration of a lit cigarette.

3.2
front area
end of a cigarette which is intended to be lit

3.3
total airflow rate
Q
volumetric flow rate of air leaving the mouth end of an unlit cigarette which is encapsulated in a measurement device having an insertion depth as defined in ISO 3308

Note 1 to entry: Under standard test conditions, Q = 17,5 ml/s.

3.4
generator for total airflow
device to maintain a constant volumetric flow rate at the exit of the mouth end of a cigarette when encapsulated in a measurement head having an insertion depth

3.5
ventilation airflow
flow of air entering an unlit cigarette other than through the *front area* (3.2) of the cigarette

Note 1 to entry: The volumetric flow rate of the ventilation airflow is normalized to the negative pressure at the mouth end of the unlit cigarette, created by the draw resistance of the cigarette when encapsulated in a measurement device having an insertion depth as defined in ISO 3308.

Note 2 to entry: In this document, a measured volumetric flow rate is referred to as Q, or Q_{SUFFIX} where a component of the ventilation flow is denoted (see 3.7 and Figure 1). Ventilation flows are measured on the inlet side to the cigarette (see Figure 2) and are denoted with a prime (e.g. Q'_{SUFFIX}) after conversion to the corresponding volumetric flow rate at the outlet to the cigarette.

Note 3 to entry: The *total airflow rate* (3.3) is defined and measured at the outlet to the cigarette and is therefore denoted as Q.

3.6
total ventilation
total volumetric flow rate of air that has entered the cigarette other than through the *front area* (3.2) of the cigarette, normalized as defined in 3.5, when the unlit cigarette is encapsulated in a measurement device having an insertion depth as defined in ISO 3308

3.7
degree of ventilation
ratio, expressed as a percentage, of the *ventilation airflow* (3.5) to the total airflow

Note 1 to entry: See Figures 1 b), c) and d).

Note 2 to entry: The degree of total ventilation comprises the airflow as defined in 3.6.

Note 3 to entry: The *total ventilation* (3.6) can be divided into the following components of ventilation airflow, with the degree of each being expressed as a percentage of the total airflow.

3.7.1
filter ventilation
Q'_F
volumetric flow rate of air that has entered the cigarette through the filter joining paper (tipping paper) between the covered part of the mouth end and the beginning of the tobacco rod, normalized as defined in 3.5

Note 1 to entry: See Figure 1 b).

Note 2 to entry: In practical instrumentation, the filter ventilation airflow rate is expected to be approximately equal to the *tipping-paper ventilation* (3.7.5) airflow rate provided that any ventilation holes are not occluded.

3.7.2
paper ventilation
Q'_P
volumetric flow rate of air that has entered the cigarette through the envelope covering the whole length of the tobacco rod, normalized as defined in 3.5

Note 1 to entry: See Figure 1 b).

Note 2 to entry: In practical instrumentation, the paper ventilation airflow rate is expected to be approximately equal to the cigarette-paper ventilation airflow rate provided that any ventilation holes are not occluded.

3.7.3
butt ventilation
Q'_B
volumetric flow rate of air that has entered the cigarette between the covered part of the mouth end of the cigarette and the position defined by the butt length (as defined in ISO 3308) appropriate to the cigarette, normalized as defined in 3.5

Note 1 to entry: See Figure 1 c).

3.7.4
burnable tobacco rod ventilation
Q'_R
volumetric flow rate of air that has entered the cigarette through its paper between the position defined by the butt length appropriate to the cigarette and the end of the cigarette which would be lit, normalized as defined in 3.5

Note 1 to entry: See Figure 1 c).

3.7.5
tipping-paper ventilation
Q'_M
volumetric flow rate of air that has entered the cigarette through the filter joining paper (tipping paper) between the covered part of the mouth end and the tobacco rod end of the tipping paper, normalized as defined in 3.5

Note 1 to entry: See Figure 1 d).

3.7.6
cigarette-paper ventilation
envelope ventilation
Q'_C
volumetric flow rate of air that has entered the cigarette through the cigarette paper between the end of cigarette which would be lit and the frontal end of the tipping paper, normalized as defined in 3.5

Note 1 to entry: See Figure 1 d).

4 Principle

Air is drawn, at a constant flow rate, in the standard smoking direction through an unlit cigarette. The individual components of ventilation are measured separately. The degrees of ventilation are obtained by calculation.

5 Standard conditions

5.1 Prior to measurement, the cigarettes shall be conditioned in an atmosphere as specified in ISO 3402.

5.2 Ventilation measurements shall be made on unlit cigarettes in accordance with the test atmosphere as specified in ISO 3402.

5.3 The direction of airflow in the cigarette shall be that which would occur when the cigarette is smoked.

6 Requirements for apparatus

6.1 The apparatus used shall allow separate assessment of the ventilation components shown in Figure 1.

6.2 The cigarettes shall be held in the measurement head, by an encapsulation device, with an encapsulation depth as defined by ISO 3308.

6.3 Seals used to hold the cigarette and partition ventilation measurement regions shall be sized and positioned appropriately to the dimensions of the product under test to minimize any systematic influence on measured parameters. See Figure 2.

6.4 The measuring pressure surrounding the cigarette contained in the measurement head, other than at the front end and the mouth end enclosed in the holding seal, shall not be more than 20 Pa lower than that of the testing atmosphere when the total airflow is applied.

NOTE Experiments conducted during the development of this method show that the measured ventilation flows reduce proportionally to increased pressure drop of the apparatus' ventilation measurement path.

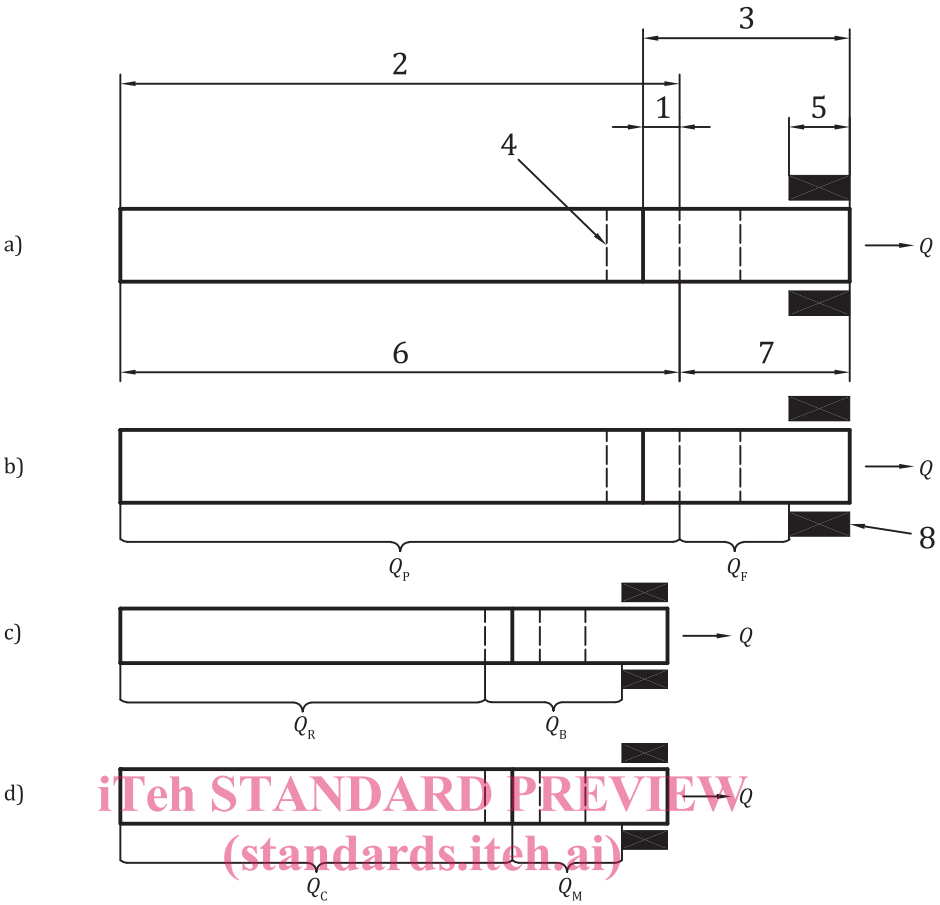
6.5 A generator for total airflow shall be used to establish the measurement conditions.

Deviations from the total airflow shall not exceed ±0,10 ml/s.

NOTE A critical flow orifice (CFO) is normally used to establish a constant total airflow for vacuum-based measurement systems.

6.6 The device used for measurement of ventilation airflows shall have no intrinsic effect on the volumetric airflow measurement.

See Figure 2.



Key

1 overlap
2 cigarette paper
3 tipping paper
4 butt mark
5 standard depth of encapsulation
6 tobacco rod
7 filter
8 encapsulation device

Total airflow rate, Q = 17,5 ml/s

Degree of filter ventilation, $V_F = \frac{Q'_F}{Q} \times 100\ \%$

Degree of paper ventilation, $V_P = \frac{Q'_P}{Q} \times 100\ \%$

Degree of total ventilation, $V = V_F + V_P = \frac{Q'_F + Q'_P}{Q} \times 100\ \%$

Degree of burnable tobacco rod ventilation, $V_R = \frac{Q'_R}{Q} \times 100\ \%$

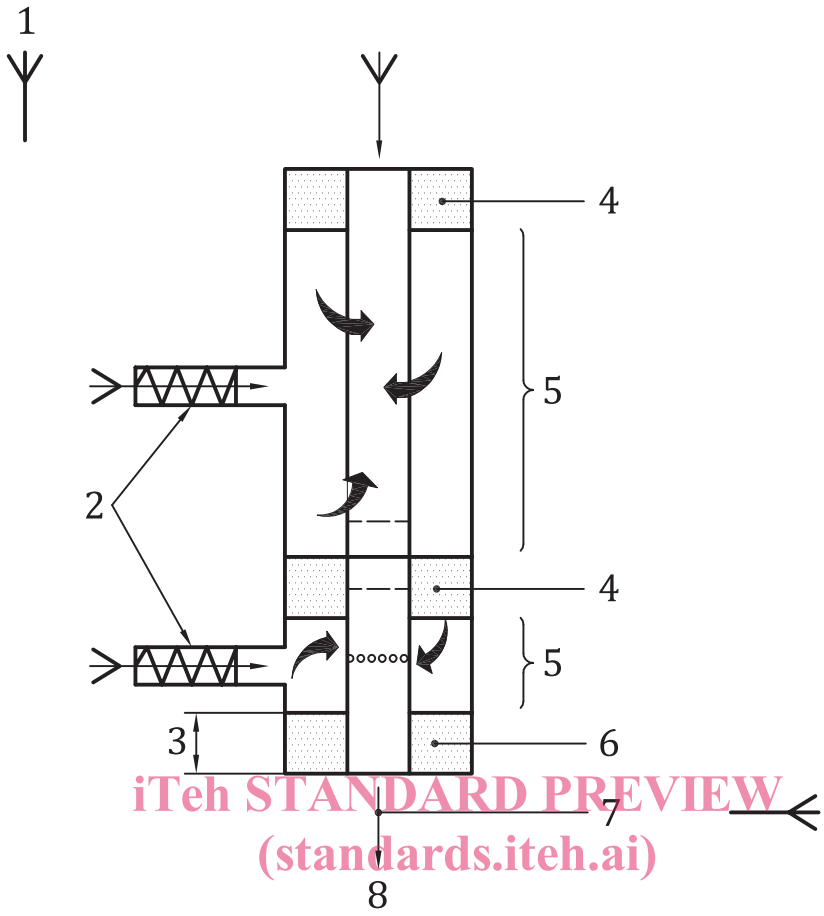
Degree of butt ventilation, $V_B = \frac{Q'_B}{Q} \times 100\ \%$

Degree of cigarette paper ventilation, $V_C = \frac{Q'_C}{Q} \times 100\ \%$

Degree of tipping paper ventilation, $V_M = \frac{Q'_M}{Q} \times 100\ \%$

NOTE See 3.5 for the significance of the prime (′) designator.

Figure 1 — Different degrees of ventilation



Key

1	test atmosphere conforming to ISO 3402	5	ventilation chamber
2	ventilation flow measurement devices	6	fixed holding seal
3	encapsulation depth conforming to ISO 3308	7	device to measure cigarette draw resistance
4	adjustable partitioning seals	8	total airflow

Figure 2 — Schematic for ventilation flow measurement

7 Sampling

A sample shall be taken which is representative, on a statistical basis, of the population to be characterized.

Samples shall be free of visible defects and creases, which may impair measurement performance.

8 Checking of apparatus

The measurement device shall be calibrated in accordance with the manufacturer's recommendations, ensuring the device is leak free prior to implementing or checking calibration.

9 Procedure

9.1 Conditioning of test cigarettes

Condition the cigarette sample selected for the test as specified in 5.1.

9.2 Calibration

Calibrate the measurement device using calibration standards and calibration procedure in accordance with Annex B.

Any calibration needs to span the range of values expected from the test sample required on the products to be measured.

9.3 Measurement

Ensure that the measurement apparatus has been adjusted to suit the dimensions of the cigarette to be tested.

Insert the cigarette samples to be tested into the measurement head and use the apparatus in accordance with the manufacturer's instructions.

Record the ventilation measurement parameters.

10 Expression of results

The reported value of any ventilation measurements shall be the mean value of individual measurements, expressed as a percentage of total airflow.

The results shall be expressed as follows:

a) individual values shall be expressed to at least one decimal place;

b) mean values shall be expressed to the first decimal place (0,05 is rounded to 0,1);

c) the standard deviation shall be expressed to the first decimal place (0,05 is rounded to 0,1).

11 Precision

The precision of this method has been estimated by selecting three cigarette product types having nominal filter ventilation values which span the normal range of measurement for ventilated products. The results for filter ventilation are reported in Reference [2], used with permission.

Data sets from 19 laboratories that complied with the collaborative study testing protocol were used in the determination of repeatability limits, *r*, and reproducibility limits, *R*, for this method.

For each of three different ventilation levels, individual sample sets comprising 10 cigarettes were tested on five different days; a new set was tested on each day. The overall mean ventilation values are shown in Table 1.

Table 1 — Filter ventilation values

Level	Mean filter ventilation value (%)
1	31,18
2	55,67
3	87,50

Outlier analysis was performed in accordance with ISO 5725-2[1] and any outliers have been removed for the determination of the mean values and *r* and *R*.

Repeatability and reproducibility statistics are given in Table 2.