CORESTA RECOMMENDED METHOD Nº 81

ROUTINE ANALYTICAL MACHINE FOR E-CIGARETTE AEROSOL GENERATION AND COLLECTION – DEFINITIONS AND STANDARD CONDITIONS

(June 2015)

0. INTRODUCTION

This Method includes the requirements found necessary for the generation and collection of e-cigarette aerosol for analytical testing purposes. This method is based on the findings reported in the CORESTA E-cigarette Task Force Technical Report, 2014 Electronic Cigarette Aerosol Parameters Study, March 2015 [1].

1. FIELD OF APPLICATION

This Method:

- defines the parameters and specifies the standard conditions for the routine analytical generation and collection of aerosol from e-cigarettes as defined in 3.14;

- specifies technical requirements for the routine analytical machine for e-cigarette aerosol generation and collection, termed as “machine” in this document, complying with the standard conditions stated within;

- does not specify aerosol trapping nor subsequent sample preparation and analytical method analyses of components in the trapped aerosol or the gas phase;

- may also be used for products other than defined in 3.14 if a specific method references this method.

2. NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this method. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7210:2013
Routine analytical cigarette-smoking machine – Additional test methods for machine verification

3. TERMS AND DEFINITIONS

For the purposes of this recommended method the following terms and definitions apply.

3.1 Test atmosphere

Atmosphere to which an e-cigarette sample or device is exposed throughout the test.

3.2 Pressure drop

Static pressure difference between the two ends of a pneumatic circuit when it is traversed by an air flow under steady conditions as described in ISO 7210:2013.

NOTE: Although the pressure drop of a device or a pneumatic circuit is defined for a specific set of reference parameters to describe its physical properties, the device could be used for measurements under conditions other than the reference parameters.

3.3 Puff duration

Interval of time, measured in seconds, during which the port of the machine is pneumatically connected to the suction mechanism.

3.4 Puff volume

Volume leaving the e-cigarette and passing through the aerosol trap.

3.5 Puff number

Number of puffs collected from an e-cigarette.

3.6 Puff frequency

Number of puffs in a given time.

3.7 Puff termination

Termination of the connection of the e-cigarette to the suction mechanism.

3.8 Puff profile

Flow rate measured over the time span for the puff at the port of machine, typically depicted graphically as a function of time.

3.9 E-cigarette holder

Device for connecting the e-cigarette to the port of the machine during aerosol generation and collection.

3.10 Aerosol trap

Device for collecting the aerosol from e-cigarettes which is necessary for the determination of specified analytes.

3.11 Port

Aperture of the suction mechanism through which a puff is drawn and to which is attached an aerosol trap.

3.12 Compensation

Ability to maintain constant puff volumes and puff profiles when the pressure drop at the port changes.

NOTE: In practice a change of the pressure drop is introduced by the connection of the test piece to the machine or the implementation of the aerosol trap.

3.13 Aerosol stream

The aerosol which leaves the mouth-end of the e-cigarette during aerosol generation.

3.14 Electronic cigarette (e-cigarette)

A device that is intended for human use in a manner similar to smoking products which contains electronic components which vaporize a liquid to generate an aerosol carried by the air drawn through the device by the user. It could be designed either as a single piece or as a modular, multiple component product for disposable, re-chargeable and/or refillable use.

NOTE: This method covers products following the above definition. This includes products described as e-cigarettes, e-cigars, e-shisha, e-pipes and other related product categories.

4. STANDARD CONDITIONS

4.1 Machine pressure drop (see 3.2)

The whole of the flow path between the port of the e-cigarette aerosol collection system and the suction mechanism shall offer the least possible resistance, and its pressure drop shall not exceed 300 Pa.

4.2 Puff duration (see 3.3)

The standard puff duration shall be 3 s ± 0,1 s.

4.3 Puff volume (see 3.4)

The standard puff volume shall be 55 ml ± 0,3 ml determined at the port of the e-cigarette aerosol collection machine in series with a pressure drop device of 1000 Pa ± 50 Pa.

4.4 Puff frequency (see 3.6)

The standard puff frequency shall be one puff starting every 30s ± 0,5 s (i.e. 2 puffs per minute).

4.5 Puff profile (see 3.8)

The puff profile shall be of rectangular shape, measured at the port of the machine with a pressure drop device of 1000 Pa ± 50 Pa. The volume V_1 plus V_3 of the increasing and decreasing parts of the profile shall not exceed 10% of the total puff volume $V_1 + V_2 + V_3$. The maximum flow rate shall be 18,5 ml/s ± 1 ml/s (see Figure 1).

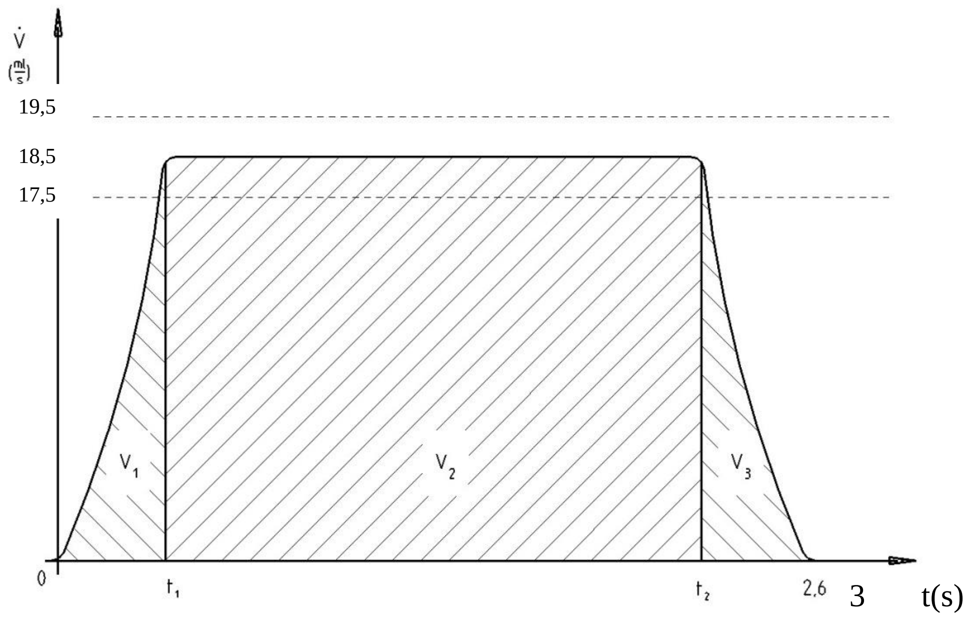

Figure 1 – Puff profile (idealized)

4.6 **Puff number** (see 3.5)

Each individual puff shall be counted and recorded until the collection process is terminated.

5. SPECIFICATION OF THE SUCTION SOURCE

5.1 General

The machine shall comply with the standard conditions (see 4.1 to 4.6).

5.2 Operating principle and puff profile

5.2.1 The machine shall include a device to draw a fixed volume of air (puff) through the e-cigarette. A schematic diagram is shown in Figure 1.

5.2.2 The machine shall produce a rectangular shaped puff profile (see 4.5).

5.3 Reliability and compensation

5.3.1 The machine shall contain devices to control the puff volume, the puff duration, and the puff frequency.

5.3.2 The machine shall possess the mechanical and electrical reliability necessary to meet the standard conditions regarding these parameters (see 4.1 to 4.6) for prolonged periods of testing.

5.3.3 The machine shall be capable of sufficient compensation (see 3.12).

When the machine has initially been set to give a puff volume of 55 ml without a pressure drop device, a reduction of no more than 2 ml shall be observed when the machine is tested with a pressure drop device of 3 kPa.

5.3.4 The machine shall be capable of taking one or more clearing puffs after the termination of the aerosol generation and collection process as needed in regards to the requirements of analytical methods to measure the aerosol components.

5.3.5 Each port shall have its own puff counter.

5.4 E-cigarette holder (see 3.9)

The design of the e-cigarette holder is such that it shall connect the e-cigarette to the port the machine in a leak free manner. It shall be impermeable to air and e-cigarette aerosol.

NOTE: For cylindrical e-cigarettes with a diameter between 4,5 and 9 mm the cigarette holder described in ISO3308 can be used without the neoprene washer.

NOTE: A specific orientation of the product during testing is not specified within this method. Different products or analytical methods may require a product orientation other than horizontal. This information should be taken into account in the machine design.

5.5 Aerosol traps

When the machine is used for collecting aerosol, a filter trap shall be fitted between the suction source and the e-cigarette, comprising the following.

a) Airtight filter holder and end caps made of a non-hygroscopic and chemically inert material, able to contain a filter disc of glass fibre material 1 mm to 2 mm thick. The rough filter surface shall face the oncoming aerosol. Different designs of aerosol trap can meet this requirement. Depending on the amount of aerosol collected filter pads with a diameter of 44 mm and 92 mm could be used but other sizes are also available. An example is given in Figure 2.

b) Filter material which shall retain at least 99,9 % of all particles having a diameter equal to or greater than 0,3 µm of a dioctyl phthalate aerosol at a linear air velocity of 140 mm/s. The pressure drop of the filter assembly shall not exceed 900 Pa at this air velocity. The content of binder shall not exceed 5% as mass fraction. Polyacrylate and polyvinyl alcohol (PVA) have been found to be suitable binders for this material.

The filter assembly shall be capable of quantitatively retaining the aerosol produced by the e-cigarette without loss. In addition, the filter assembly shall be chosen so that the increase in pressure drop of the assembly does not exceed 250 Pa when measured after the completion of aerosol collection.

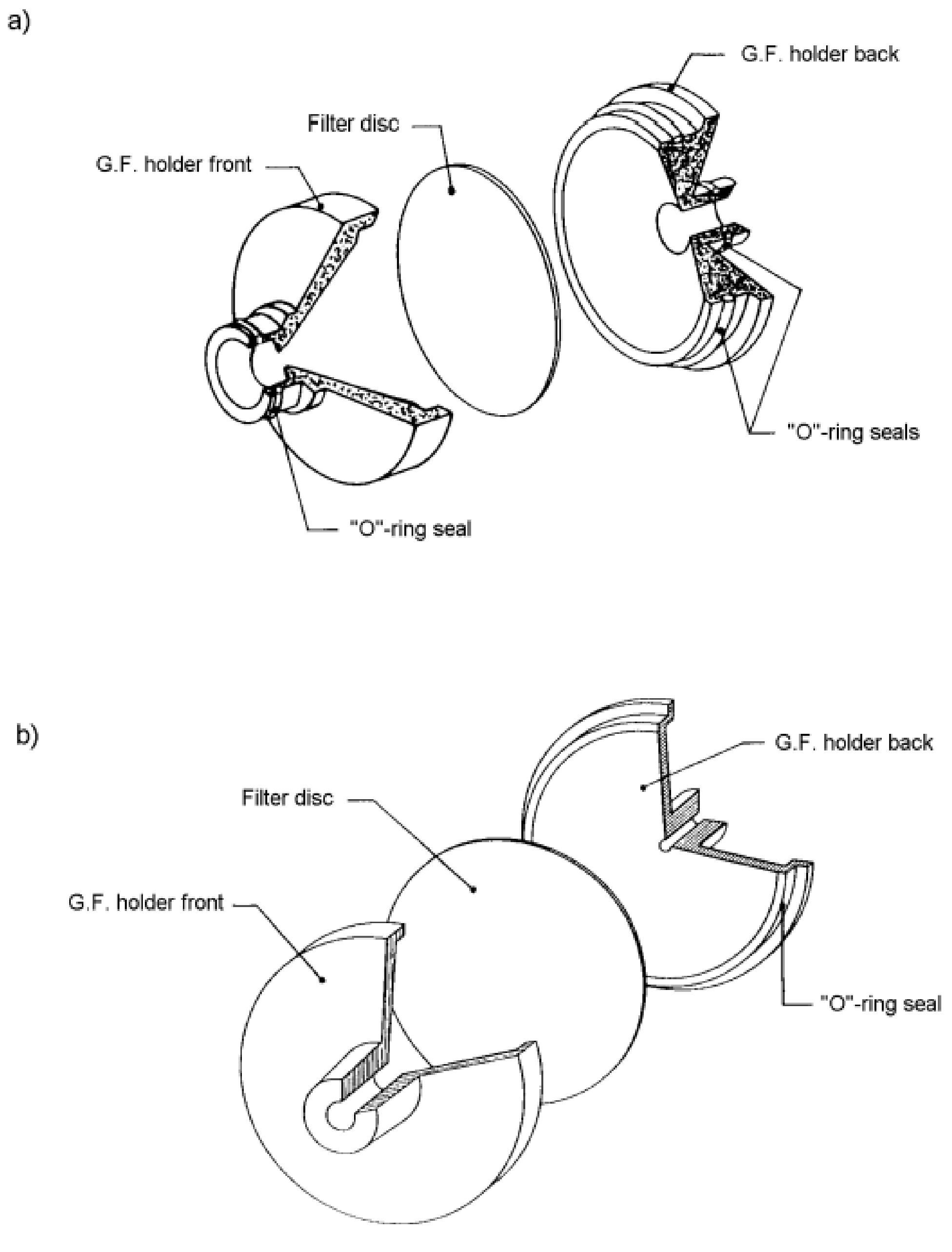

Figure 2 – Two examples of glass fibre filter (GF) aerosol traps (schematic)

5.6 Puff activation

If the aerosol generation process of the e-cigarette is started other than by drawing the puff, an additional activation mechanism shall be used that activates the e-cigarette and is synchronized to the puff. The activation shall not start later than 0,1s after starting the puff and shall not be stopped later than 0,1s after the puff is finished.

NOTE: Some products may require a pre-heating time for proper function. In this case, follow the user instruction of the product and note this in the reporting documents.

5.7 Termination of aerosol generation and collection process

The machine shall be capable of terminating and/or interrupting the aerosol generation and collection process after a pre-defined number of puffs.

If the test requires exhaustion of the liquid or battery, the termination of the aerosol collection process could be done by the operator observing the process. Also, the termination of the aerosol collection process could be done by a sensor (aerosol detector) located between the e-cigarette and the aerosol trap. The sensor shall be positioned as close as possible to the e-cigarette. When the end-point of aerosol generation is determined, the machine shall continue the started puff and then stop the aerosol generation and collection process.

NOTE: Checking any indicator built into the e-cigarette is not an appropriate confirmation of aerosol generation. The indicator could fail for several reasons, while the product is still producing aerosol or it could falsely indicate the production of aerosol.

NOTE: The observation of the aerosol generation process by the operator could be done in different ways. One option is the direct visible observation by the operator requiring that the e-cigarette holder is connected via a transparent (e.g. glass) tube to the port of the machine. Another possibility is to monitor the weight loss of the product or the weight of the used traps during the aerosol generation process. Therefore specific laboratory methods have to be set up and validated.

5.8 Test atmosphere variability

The temperature and relative humidity of the test atmosphere during machine preparation and testing shall be kept within the following limits:

– temperature: ± 2 C;

– relative humidity: ± 5 %.

6. BIBLIOGRAPHY

[1] *CORESTA E-cigarette Task Force Technical Report*, 2014 Electronic Cigarette Aerosol Parameters Study, March 2015

[2] *ISO 558:1980*, Conditioning and testing – Standard atmospheres – Definitions

[3] *ISO 3308:2012*, Routine analytical cigarette-smoking machine – Definitions and standard conditions