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Test method for the evaluation of permeability and filtration efficiency distribution of bag filter medium

Méthode d'essai pour l'évaluation de la perméabilité et de la distribution de l'efficacité de filtration d'un média filtrant à poches

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Foreword

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This document was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases.*

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

The main purpose of using dust collector systems is to separate dust particles from dirty gases. The dry type filtering dust collectors, bag filter systems are one of the most widely used industrial dust collectors such as municipal garbage incinerators, coal fired boilers, iron makings, cement factories, power plants, etc. They are also used to improve the local working environment where dust is emitted. For the bag filter systems, the operations to collect the dust particles at the surface of the filter for relatively long periods, and to remove the accumulated dust on the filter away instantaneously are conducted. Therefore, the dust particles are collected inside the filter immediately after the dust removal operation until the dust layer is completely formed on the filter and particle collection on the filter surface begins. Therefore, their most important performances, filtration efficiency and pressure drop depend upon the characteristics of the filter medium installed in them.

Such as non-woven filter medium for bag filter systems packs densely with relatively large fibres. Although fibre size and its orientation are different slightly in the entire filter medium, packing structure of the medium (packing density and area mass of fibres, thickness of the medium, etc.) can vary depending on the position of the filter medium due to the manufacturing method.

The non-uniformity (variation by the position) in the packing structure of the-medium affects its pressure drop, gas permeability and filtration efficiency. As a result, the local values of the pressure drop, gas permeability and filtration efficiency in small domains in the medium are also distributed unevenly. However, the non-uniformity of these performances has been ignored. In many cases of commercial filters, their thickness, area mass, fibre packing density, and gas permeability are only indicated as the average specifications.

The non-uniformity of these properties of the filter medium can cause various troubles in operation and reducing the collection performance of the bag filter system. The part with relatively lower packing density of fibres in the filter medium allows higher gas flow rate, but the densely packed part provides lower gas flow rate. Thus, the gas and dust flows concentrate in areas with low packing density, causing clogging in those areas. Since the dust particles are collected inside the filter immediately after the cleaning operation of accumulated dust on the medium until the dust layer is completely formed on the filter (transition to the cake filtration process), the area with a relatively higher gas permeability can give the lower filtration efficiency, and the dust easily leak from there. These phenomena finally can accelerate the further deterioration of the filter medium.

Accordingly, in order to accurately evaluate the performance of the filter medium, it is preferable to measure not only the average value of each property but also its distribution based on globally consistent methods and standards.

Test method for the evaluation of permeability and filtration efficiency distribution of bag filter medium

1 Scope

This document specifies a measuring method for the distribution of thickness, area mass, gas permeability and collection efficiency in the filter medium, and applies to both woven and non-woven filter medium.

This document provides a method for sampling specimen (position, size and number) from the filter medium required to obtain its performance distribution accurately.

The purpose of this document is to provide more accurate information about the morphology of the filter medium for users, and not to compare grade the performance of the filter medium.

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

ISO 5084, *Textiles — Determination of thickness of textiles and textile products*

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

3 Terms and definitions

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

ISO and IEC maintain terminology 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
lot
minimum unit for the manufacture of a product with the same specification

3.2
roll
minimum unit for filter shipping from the manufacturer

3.3
area mass
mass per unit area for a two-dimensional object

4 Determination of sampling

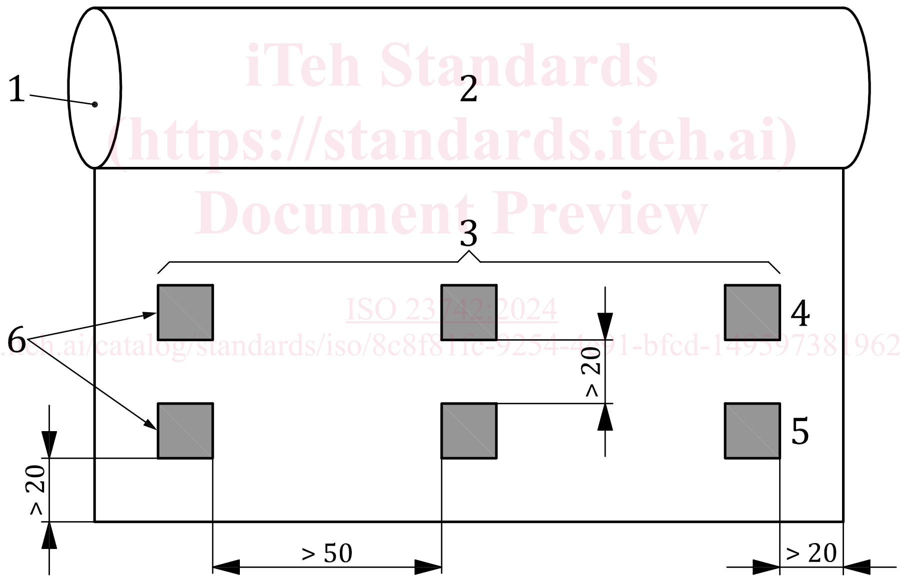
4.1 General

As explained in Annex A, as the number of sample sheets increases, the accuracy of the non-uniformity measurement improves. The number of sample sheets corresponding to the required reliability shall be specified. Since the position of the sample sheets in the roll of the filter medium directly influences the obtained distribution for each measurement item, it shall be specified. As the specimen strip size for each measurement item decreases, the non-uniformity on smaller scales is measured. Hence, they shall be specified. Since reducing the sample sheet size also yields more localized distributions with finer resolution, it shall also be standardized.

4.2 Collection position, size and shape of representative sample sheets

Figure 1 shows the position where sample sheets are cut from the filter medium roll. Sample sheets shall be taken from at least 20 cm inside the end and both sides of the roll of the filter medium, and avoid its selvedge. The lateral distance between the sample sheets shall be at least 50 cm equally spaced. The maximum number of sample sheets which are taken from a roll in the lateral direction is defined as 5. When the required number of sample sheets are not obtained from the row closest to the end of the filter roll (first row), the remaining sample sheets shall be taken in the same way from the next farther row, more than 20 cm apart. The size of the sample sheet shall be more than 30 cm square (30 cm × 30 cm). All the measurement items are tested sequentially on one specimen strip cut out from each taken sample sheet.

Dimensions in centimetres



Key

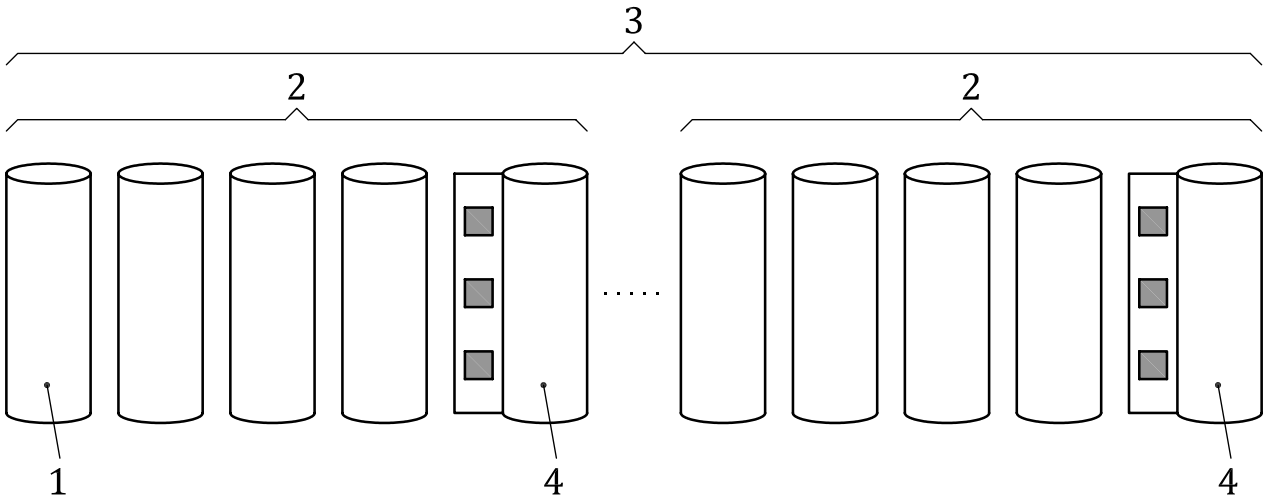
1	filter roll	4	2nd row
2	five sample sheets from one roll	5	1st row
3	less than five sample sheets from one row	6	sample sheets larger than 30 cm square

Figure 1 — Position to take sample sheets from the filter medium roll

4.3 Number of representative sample sheets

As the number of sample sheets increases, the reliability of the measured results increases, and the confidence interval decreases. Therefore, it is preferable to collect more sample sheets and evaluate each measurement item. However, as an increase in the number of sample sheets results in an increase in cost, the necessary and sufficient number of sample sheets shall be determined from the sample survey theory explained in Annex A. Namely, at least 15 sample sheets shall be sampled per lot.

The selection of filter rolls to take sample sheets from one lot is shown in Figure 2. To evaluate the longitudinal variance, at least three rolls shall be selected evenly for each lot of the filter medium, and the number of sample sheets allowed to be taken from a roll is limited to five, respectively.



Key

1 filter roll
2 select at least three filter rolls per lot
3 one lot
4 maximum of five sample sheets per roll (sample sheets of larger than 30 cm square)

Figure 2 — Number of sample sheets to be acquired per lot of the filter medium

5 Preparation of specimen strips

5.1 General

A specimen strip to measure all three evaluation items (thickness, area mass, gas permeability) shall be cut out from each sample sheet taken.

5.2 Standard atmosphere for conditioning and testing

The atmosphere for conditioning and testing specimen strips shall be defined according to ISO 139. This atmosphere has a relative humidity of (65 ± 2) % and a temperature of (20 ± 2) °C. In tropical regions between the Tropic of Cancer (23°26'22" N) and the Tropic of Capricorn (23°26'22" S), centred on the equator, a temperature of 27 ± 2 °C may be used, subject to the agreement of the interested parties.

5.3 Conditioning of specimen strips

Before measurement, specimen strips shall be brought into equilibrium with the standard atmosphere for testing by exposing them to this atmosphere in a tension-free condition. Equilibrium is considered to have been reached when the difference between successive weightings carried out at intervals of at least 2 h does not exceed 0,5 % of the final mass of the filter medium when conditioned in this atmosphere according to ISO 3801. The exposure time shall be a maximum of 8 h.

5.4 Size of specimen strips

A 30 cm square (30 cm × 30 cm) specimen strip shall be cut out from the centre of the taken sample sheet. In cases where 30 cm square is not appropriate for the measurement, an alternative length square of 15 cm to 40 cm or a circular specimen strip of 8 cm to 23 cm diameter may be chosen.

6 Measurement method - Thickness

6.1 General

Thickness of the filter medium is defined as the perpendicular distance between two reference plates exerting a certain pressure. The thickness of a specimen strip shall be measured as the distance between the reference plates on which the specimen rests and a parallel circular presser-foot that exerts a specified pressure on the area of the textile under test. A test specimen strip shall be placed between two reference plates which exert a known pressure on the specimen. The perpendicular distance between the reference plates is measured and recorded after a specified period.

6.2 Apparatus

Metrological confirmation of the test apparatus shall be carried out in accordance with ISO 10012.

6.2.1 Thickness tester

The necessary elements and recommended dimensions to be used with the thickness tester shall be in accordance with ISO 5084.

6.2.2 Thickness gauge

The thickness gauge shall be able to measure and register the distance between the two plates to an accuracy of 0,01 mm.

6.3 Procedure

The thickness at three points equally spaced on both diagonals of the specimen strip (total five points) shall be measured under exerting the specified pressure after the specified period and using the thickness tester and the thickness gauge. As shown in Annex C, thickness can depend on the exerted pressure. Recommended period and exerting pressure are (30 ± 5) s and (1 ± 0,01) kPa, respectively. In cases where these specifications are not appropriate for the measurement, an alternative period of more than 10 s and exerting pressure of less than 15 kPa can be chosen. The arithmetic mean of the measured thicknesses in the accuracy of 0,01 mm shall be defined as the thickness of the specimen strip. Recommended specimen strip size for the thickness measurement is 30 cm square (30 cm × 30 cm), according to ISO 5084. In cases where this specification is not appropriate for the measurement, an alternative size of 10 cm to 30 cm square (10 cm to 30 cm × 10 cm to 30 cm) may be chosen.

7 Measurement method - Area mass

7.1 General

The area mass (mass per unit area) shall be determined by exposing the specimen strip taken from sampled filter medium. Specimens of known dimensions are then taken and weighed and the mass per unit area is calculated.

7.2 Apparatus

Metrological confirmation of the test apparatus shall be carried out in accordance with ISO 10012.

7.2.1 Precision balance

The precision balance shall be able to determine the mass of pieces with the accuracy of ±0,2 % of the determined mass. An accuracy of 0,001 g is required.