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Sampling and test method for cleanable filter media taken from filters of systems in operation

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 remove dust particles from dirty gases. The dry type filtering dust collectors, known as bag filters, are one of the most widespread industrial dust collectors and are used in applications such as municipal garbage incinerators, coal fired boilers, iron making, cement factories, power plants, etc. Especially, in municipal garbage incinerators, bag filters have been used frequently to overcome dioxin emission[1],[2].

Since filter media are used under various gas and dust conditions for a long time, their physical and chemical properties change (deteriorate) with operating time due to various causes[3] to [12]. The important filter characteristics such as collection performance and residual pressure drop change with the operation period. Since users of bag filter systems have usually evaluated the parameters associated with the change in the filter properties with their own methods, the results obtained were not easily compared with each other. For this reason, the establishment of a standard for operation, management, and maintenance of filter systems is important to allow prediction of the timing of replacement and/or service life time of filter media.

Changes in the physical and chemical properties of the filter medium, i.e., physical and chemical degradation are caused by many factors, such as heat, particle accumulation, reaction with corrosive gases and deposited particles, and mechanical reasons like clogged weave openings and increasing size of weave openings, the combination of those factors and so on. The filter medium damage can be analysed through the fault tree analysis in Annex A. Clogged weave openings reduce the permeability of the filter medium; and increasing the size of weave openings lessens the collection performance of the filter medium. The reaction with corrosive gases and deposited particles changes properties of the filter fibre material itself and decreases the tensile strength, tenacity, flexibility of the filter medium and so on. These changes cause mostly adverse effects to the filter medium. This can result in the breakage of filter media and leakage of dust to the atmosphere.

Therefore, since it is important to evaluate the property changes of filter media in order to predict the timing of replacement and/or service life time, ISO 16891, which specifies test methods for evaluating degradation of tensile stress of cleanable filter media, has been published. However, test methods for other evaluation parameters such as permeability, collection efficiency, fibre diameter of used filter media, mass and size distribution of deposited particles, have not yet been specified.

Industrial bag filter systems, in general, handle large amounts of dirty gas so that a system with a large number of filter elements in parallel is needed to remove the dust. The degree of degradation of filter properties depends on the location of the filter in the system because the dirty gas usually enters the system in an irregular flow pattern. Furthermore, the method used for sampling and storage of the used filter, and the preparation method of the test specimen should be defined. By standardizing these test methods, it is possible to accurately assess the deterioration of individual filter media.

This document provides a standard method for sampling filter elements from a dust collector system in operation, and a test method for monitoring sampled filter elements and the system through measurement of basic filter properties.

Sampling and test method for cleanable filter media taken from filters of systems in operation

1 Scope

This document specifies a method for sampling fabric filter medium from a filter system in operation, and a test method for evaluating the degradation of the sampled filter medium. It applies to both woven and nonwoven fabric filter media.

This document specifies a method for removing used filter medium from a dry type filtering dust collector, a method for removing dust from the sampled filter medium as part of preparation for testing, and measurement parameters for the test specimen. The number of filter elements to be sampled, their positions in the blocks of filter elements in the dust collector, the position and the size of the test specimens to be cut out from the filter element, measurement parameters and their test methods are also specified.

This document also specifies a storage and transportation method for the sampled filter medium that will protect the health of workers and people conducting the tests.

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 16891:2016, *Test methods for evaluating degradation of characteristics of cleanable filter media*

ISO 9237, *Textiles — Determination of the permeability of fabrics to air*

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
air permeability
gas volume flow rate per unit filtration area at pressure drop of 124,5 Pa

[SOURCE: ISO 16891:2016, 3.2]

3.2
cleanable filter
filter designed to permit the removal of collected dust by application of an appropriate technique

[SOURCE: ISO 29464:2017, 3.2.73, modified — Note 1 to entry has been removed.]

3.3
degradation
change in physical and chemical performance of a filter medium caused by interaction with corrosive gases

[SOURCE: ISO 16891:2016, 3.9]

3.4
elongation
incremental change in length of test specimen determined by tensile test

[SOURCE: ISO 16891:2016, 3.10]

3.5
nonwoven fabric
filter medium manufactured using fabric made from long fibres, bonded together with each other by chemical, mechanical, heat or solvent treatment

[SOURCE: ISO 16891:2016, 3.21]

3.6
tensile strength
value of the maximum load divided by the width of test specimen

[SOURCE: ISO 16891:2016, 3.27]

3.7
woven fabric
filter medium manufactured using a fabric formed by weaving

[SOURCE: ISO 16891:2016, 3.31]

3.8
pulse cleaning
process for removing collected particulate from a filter element by injecting compressed air in short bursts from the *clean side* (3.11) of the filter element

3.9
snap ring
metallic ring-shaped spring mounted at the open end of the filter element

3.10
dirty side
upstream side of the filter element

3.11
clean side
downstream side of the filter element

3.12
retainer
cage
device supporting the filter element as it performs dust collection

4 Sampling of a representative filter element

4.1 General

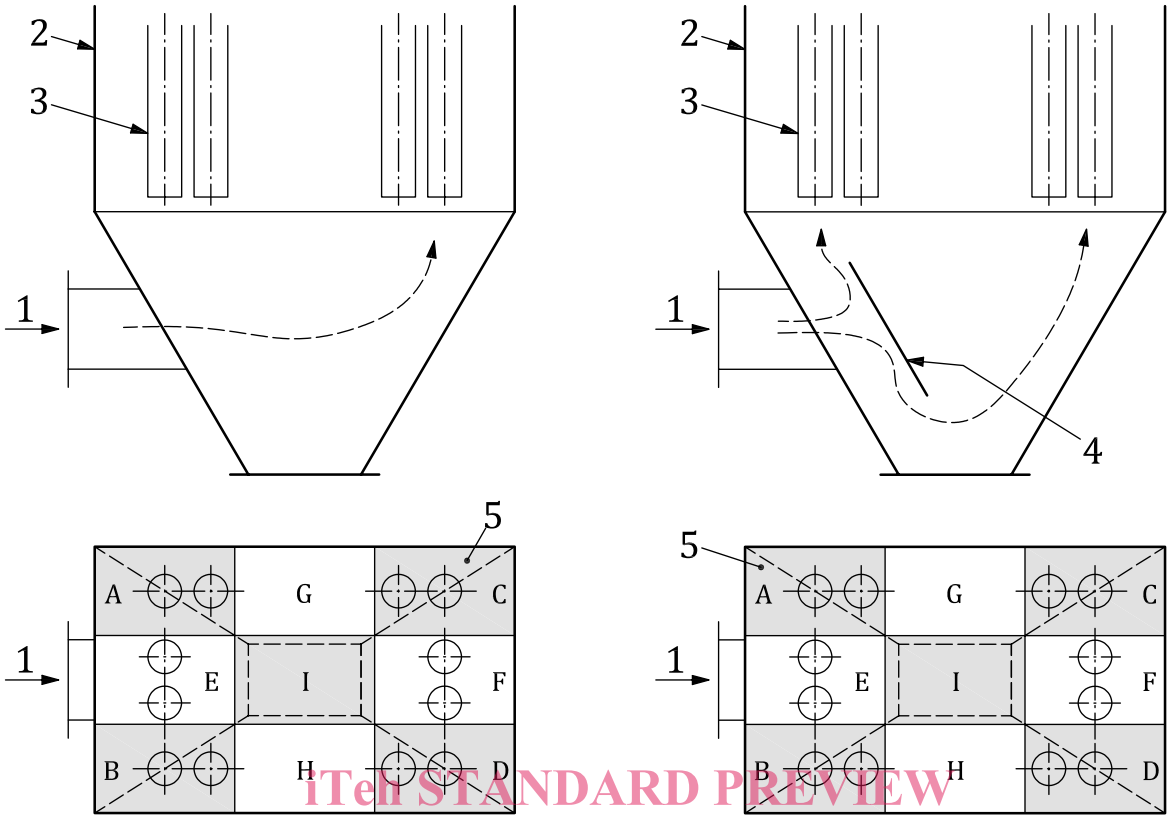
To evaluate or monitor the service life time of filter elements, it is essential to sample a representative filter element, since the degree of degradation of filter properties depends not only on physical causes

but also on the location of the filter in the system. It is difficult in practice to select a representative filter because of the size and structure of the system, arrangement of filter elements, gas flow distribution in the system and so on, which are different for each individual system. Even in the same system, the degree of degradation may vary significantly with the specific position of the element in the filter array. It is often extremely difficult to identify exactly the most deteriorated filter in the system. The best practice approach may be to choose as representative a filter element from the area in the system that is observed to be the most deteriorated.

4.2 Selection of the sampling block in the system

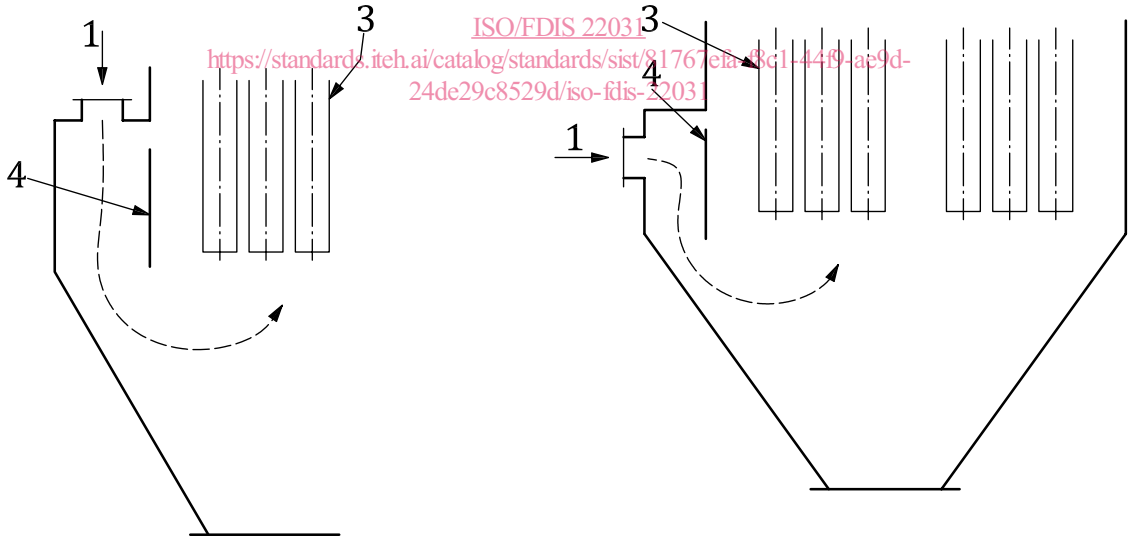
4.2.1 Sampling block

The most serious deterioration is expected to appear in the area where the dirty gas concentrates. The general location of this area depends on whether the bag filter system has a baffle plate at the dirty gas inlet. When the dirty gas flows into the system without a baffle plate, the gas will flow to the opposite side of the system and change the flow direction as shown in Figure 1 a) so that the representative filter element is recommended to be sampled from a block either at the centre or at the opposite side of the system from the dirty gas inlet, for instance, block F, C, D. When the system has a baffle plate, the dirty gas flow is divided by the baffle plate and will come together again downstream as shown in Figure 1 b). Therefore, the filter element is recommended to be sampled from a block where the gas flow concentrates after it is divided by the baffle plate, for instance, block E or F. Alternatively, the filter element can be sampled from the block identified by a flow analysis to be where the dirty gas concentrates, for instance, block E, I, F for the left-hand side and G, I, H for the right-hand side as shown in Figure 1 c) and d).



a) Bag filter system without baffle plate

b) Bag filter system with baffle plate



c) Area where dirty gas flow concentrates is already identified by flow analysis etc.

d) Area where dirty gas flow concentrates is already identified by flow analysis etc.

Key

1 dirty gas entry
2 bag house
3 filter element
4 baffle plate
5 block of filter elements in the bag house (A to I)

Figure 1 — Examples of sampling block

4.2.2 Number of filter elements to be sampled

The number of filter elements to be sampled shall be determined by the number of blocks of filter elements in the bag filter system.

a) Bag filter with one block: at least one sample.

b) Bag filter with multiple blocks: at least one filter element per block shall be sampled.

4.2.3 Sampling time and interval

The filter element shall first be sampled around one year after its operation starts. Thereafter, it is preferable to sample at about one-year intervals.

A sample of the unused fabric filter shall be stored as reference to create a baseline for comparison.

Though plants installing a bag filter system usually operate continuously, the facility shall be shut down when sampling the filter media. Therefore, it is preferable to sample the filter element during a routine shut-down period of the facility, such as during periodic inspection and repair.

4.3 Procedure for sampling

4.3.1 General

Sampling of the filter element is carried out by replacing old and installing new filter elements in the sequence described in 4.3.2 to 4.3.5.

4.3.2 Preparation

a) Stop the dust laden gas flow to the bag filter system, operate the system for more than 10 min with clean air alone, and repeat pulse cleaning several times to remove dust from the filter element as much as possible.

b) The flow rate and pressure drop across the filter element designated as a sample shall be measured.

c) Stop the clean air supply.

d) Then open the lid on the dirty side of the system and take a picture of the arrangement of the bag filter from the bottom of the system.

4.3.3 Sampling of filter element

a) Open the lid on the clean side of the system.

b) Remove the retainer holding the filter element. Then remove the filter element by loosening the snap rings used for fixing the element in place.

c) Pull down the sampled filter element to the dust bin with a rope while preventing penetration of dust inside the filter medium and the re-entrainment of dust from the filter medium. Depending on the situation, it may be pulled up to the clean side of the system. If this option is chosen, care shall be taken not to contaminate the clean side of the system with dust from the removed filter.

NOTE 1 When filter element can be dropped down softly to the dust bin without a rope, the use of a rope is not necessary.

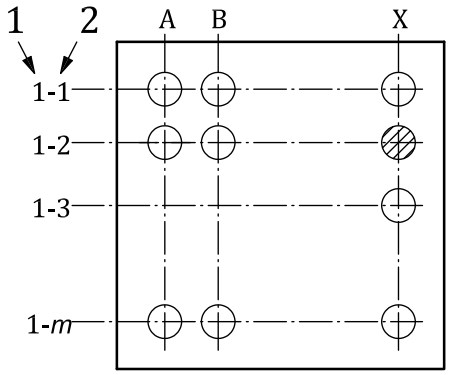
d) Measure the mass of the filter element, if possible, and record the value in grams (g) for reference.

e) Put the sampled filter element into a polyethylene bag, etc. and seal the bag tightly. In order to prevent changes in the properties of the filter, the bag should be kept under vacuum or filled with an inert gas, if possible.

NOTE 2 This is to prevent absorption of moisture and re-entrainment of dust. Hence, it is desirable to put the sampled filter element into a double layer polyethylene bag.

f) Record on the polyethylene bag details of the position of the sampled filter element in the filter element array, including block number and position within the block. An example of the position of the filter elements in the system is shown in Figure 2 (the hatched filter element location is 1-2-X).

NOTE 3 When a plan of the filter element array is provided, the location of the sampled filter element should be marked on the plan.



Key

1 block number in the system
2 row number in the block (1 to *m*)
X column number in the block (A to X)

Figure 2 — Arrangement plan of fabric elements in the bag

4.3.4 Installation of new fabric filters

Install new filter elements at the same positions in the same blocks as those where the sampled filter elements have been removed.

4.3.5 Transportation of sampled filter elements to the test lab

The sampled filter elements shall be transported by the following process.

a) The polythene bags containing the sampled filter elements shall be put in a cardboard box not in contact with each other and sealed tightly to prevent re-entrainment of attached dust, etc. In the case of handling, care shall be taken that the dust does not re-entrain.

b) The sampled filter elements shall be sent by an appropriate means of transport to arrive at the test laboratory within 2 days after sampling.

NOTE Each country has laws and regulations on the handling and transporting hazardous materials and industrial wastes.

5 Test method for the sampled filter fabric

5.1 General

The sampled filter elements shall be selectively tested for the characteristics shown below after negotiation between stakeholders. In the negotiation, consideration should be given to whether or not the filter is damaged, and the degree of damage.