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Health and safety in welding and allied processes — Equipment for capture and separation of welding fume —

Part 2: Requirements for testing and marking of separation efficiency

Hygiène et sécurité en soudage et techniques connexes — Équipements de captage et de filtration des fumées —

Partie 2: Exigences relatives aux essais et marquage de l'efficacité de séparation

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www. iso. org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*.

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.

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

A list of all parts in the ISO 21904 series can be found on the ISO website.

This first edition cancels and replaces ISO 15012-1.

Introduction

It is common practice in the fabrication industry to control exposure to welding fume using local exhaust ventilation equipment that, following capture and separation of the fume, returns the extracted air to the workplace or exhausts it to the atmosphere. It is important that such equipment has high separation efficiency so that as little fume as possible is recirculated or exhausted. This document has therefore been developed to specify a test method for determining the efficiency of welding fume separation equipment and the requirements of the test method.

Health and safety in welding and allied processes — Equipment for capture and separation of welding fume —

Part 2: Requirements for testing and marking of separation efficiency

1 Scope

This document specifies a method for testing equipment for the separation of welding fume in order to determine whether its separation efficiency meets specified requirements.

The method specified does not apply to testing of filter cartridges independent of the equipment in which they are intended to be used.

This document applies to equipment that is manufactured after its publication.

NOTE General ventilation systems are excluded from the Scope of ISO 21904-1.

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 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 15011-1:2009, *Health and safety in welding and allied processes — Laboratory method for sampling fume and gases — Part 1: Determination of fume emission rate during arc welding and collection of fume for analysis*

ISO 21904-1:2020, *Health and safety in welding and allied processes — Equipment for capture and separation of welding fume — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21904-1 and the following 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
free-standing unit
separation equipment with an integrated fan

3.2
modular system
separation equipment consisting of a scaleable filter system with the same filter elements and conditions normally connected to a single fan

3.3
welding fume source
source generating welding fume by welding process that charges separation equipment to perform separation efficiency tests

3.4
emission rate
mass of the particles emitted by the welding fume source per time

Note 1 to entry: The emission rate is expressed in milligrams per second.

4 Principle

The method is based on the methods specified in EN 1093-6[10] and EN 1093-7[11]. Under test, the welding fume separation equipment is charged by welding fume generated by a welding process. The welding fume concentrations are measured in the incoming and exhausted air of the separation unit. The welding fume separation equipment under test is operated under defined conditions, according to its intended use.

The emission rate of the welding fume source is measured separately. Therefore, the welding fume generated by the source is sampled on preweighed filters over a period of time.

The air volume flow rate of the welding fume separation equipment and the testing time shall be measured during the separation efficiency test. Emission rate, testing time and air volume flow rate are used subsequently to calculate the concentration of welding fume in the incoming air. Welding parameters should be the same when emission rate and separation efficiency test are performed.

Before separation efficiency measurements are made, all welding fume separation equipment are charged for a period of 30 min using the welding fume source.

For equipment with filters that are not intended to be cleaned, the concentration of welding fume passing through the separation equipment is measured subsequently for a period of 30 min and the measured concentration is used, together with the welding fume concentration calculated from the welding fume emission rate, to determine the separation efficiency.

For equipment with cleanable filters, an additional separation efficiency measurement is performed after a further welding period without measurement and filter cleaning. The average of the two separation efficiencies is calculated.

Two tests are performed and the average, the 95 % one-sided confidence interval and the lower confidence limit value of the separation efficiency are calculated according to ISO 2602. If the resulting lower confidence limit value is less than the required separation efficiency, consideration shall be given to improve the filter unit design.

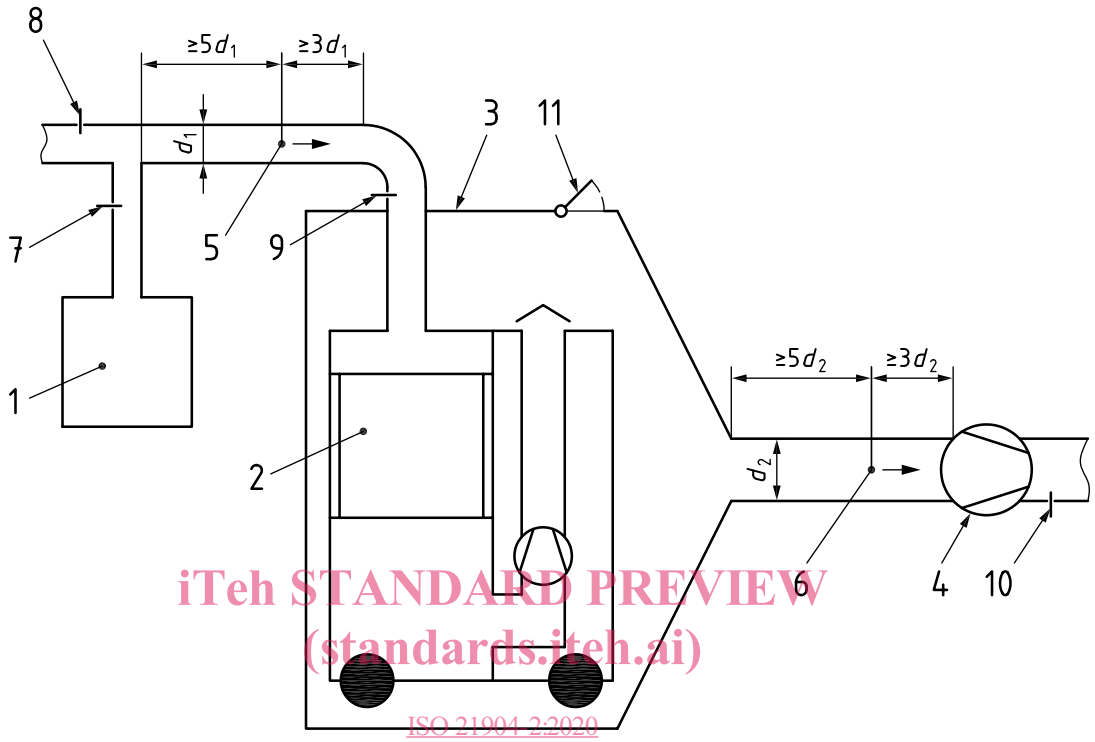
5 Apparatus

5.1 Welding fume source, capable of maintaining an emission rate of 10 mg/s ± 2 mg/s throughout the test period.

The welding fume source shall be fitted with an extraction hood that retains all the welding fume emitted and shall be designed in such a way that it can be connected to the inlet duct of the test cabin, as described in Figure 1, or directly to welding fume separation equipment with a ducted outlet, as described in Figure 2. It shall be possible to determine the welding fume emission rate in situ without disturbing the welding set-up in any way. An example of a suitable welding fume source and parameters required to achieve the required welding fume emission rate are described in Annex B.

5.2 Test cabin, consisting of an enclosure for the welding fume separation equipment under test, connected to the welding fume source via an upstream measurement duct.

The cabin is connected to a downstream measurement duct and an air mover (see Figure 1). The air volume flow rate through the air mover is adjusted to between 95 % and 100 % of the air volume flow rate in the upstream duct, thus ensuring a small positive air pressure in the cabin.



Key

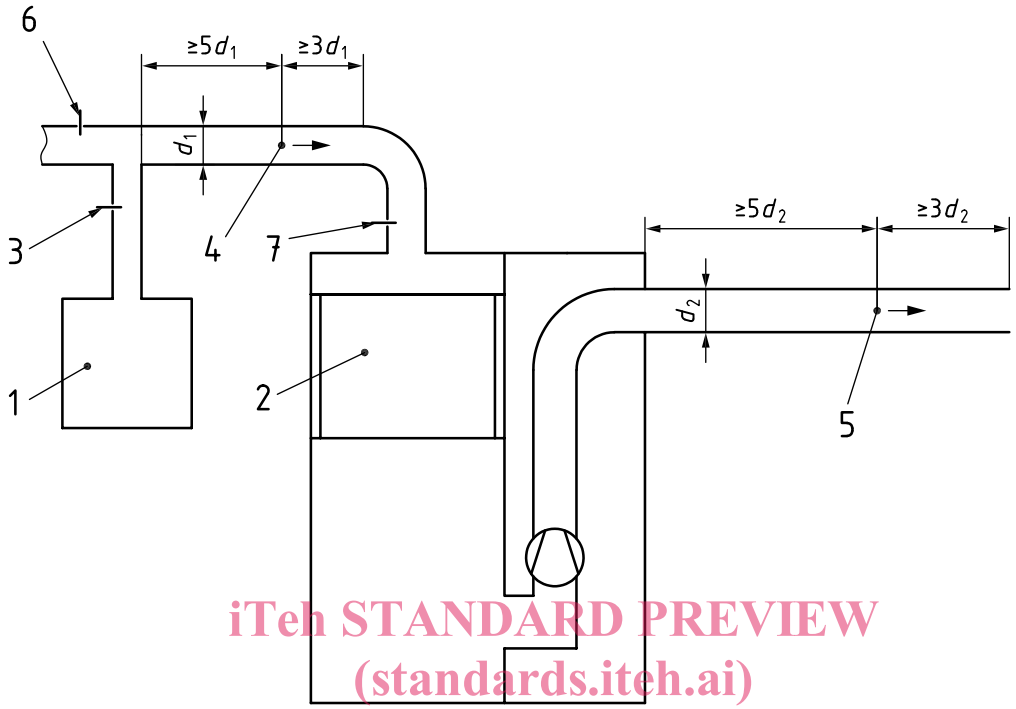
1 welding fume source (see Figure B.1)
2 welding fume separation equipment
3 test cabin
4 air mover
5 position for measuring the air volume flow rate in the upstream duct, $q_{V,1}$
6 positions for measuring the air volume flow rate in the downstream duct, $q_{V,2}$ and isokinetic sampling of welding fume in the downstream duct
7 damper (to control the air volume flow rate passing through the welding fume source in order to avoid shielding gas disturbance)
8 damper (to ensure that all welding fume is captured, even when filter units with a low air volume flow rate are under test)
9 damper (to regulate the total air volume flow rate passing through the separation equipment)
10 damper (to control the air volume flow rate in the downstream duct in order to achieve a slight overpressure in the cabin)
11 gap with a flap (to prevent damage on the cabin in case of high overpressure)
d_1 upstream duct diameter
d_2 downstream duct diameter

Figure 1 — Example of test cabin (schematic layout)

The positions for measuring the air volume flow rate and isokinetic sampling of welding fume in the downstream duct are not the same, but are shown in Figure 1 for convenience. They shall comply with the dimensions marked in Figure 1.

5.3 Test arrangement for welding fume separation equipment with a ducted outlet, consisting of a welding fume source connected to the equipment via an upstream measurement duct.

The outlet of the welding fume separation equipment is directly linked to the downstream measurement duct (see Figure 2).



Key

1 welding fume source
2 welding fume separation equipment
3 damper (to control the air flow passing through the welding fume source in order to avoid shielding gas disturbance)
4 position of equipment for measuring the air volume flow rate in the upstream duct
5 position of equipment for measuring the air volume flow rate and the welding fume concentration in the downstream duct
6 damper (to ensure that all welding fume is captured, even when filter units with low air volume flow rates are under test)
7 damper (to regulate the total air flow passing through the separation equipment)
d_1 upstream duct diameter
d_2 downstream duct diameter

Figure 2 — Test arrangement for welding fume separation equipment with a ducted outlet (schematic layout)

5.4 Air volume flow rate measurement equipment, capable of measuring rates up to 2 000 m^3/h continuously, to within an accuracy of ±10 % or better.

The following combination of equipment is suitable.

A flow meter with a calibrated relationship between pressure difference and air volume flow rate, e.g. an orifice plate, together with a digital manometer to measure the pressure difference across it. The digital manometer shall have a logging capability or be connected to a logging system with a logging frequency of 1 min or less.

A device for measuring air volume flow rate with equivalent performance is also suitable.

National standards shall be taken into consideration for the calibration of all equipment.

6 Test method

6.1 Selection of test arrangement

Use the test cabin illustrated in Figure 1 or the test arrangement shown in Figure 2. Any welding fume separation equipment (including individual modules of a modular system) can be tested using the test cabin depicted in Figure 1, provided it can be fitted into the test cabin. For an example of a test cabin, see Annex A.

Only welding fume separation equipment with a ducted outlet can be tested using the arrangement shown in Figure 2.

6.2 Test conditions

Carry out the test under conditions that are similar to the normal working conditions for the equipment under test.

For modular welding fume separation equipment, if the designed air volume flow rate is greater than 2 000 m^3/h, carry out the test of separation efficiency using a specially made scaled down typical module. If different fans can be used in combination with the welding fume separation equipment, carry out the test of separation efficiency using the minimum and maximum air volume flow rates recommended by the manufacturer.

6.3 Procedure

6.3.1 Source emission rate measurement

Determine the emission rate of the welding fume source using the exact conditions used during testing and the general approach specified in ISO 15011-1. Weld while sampling total welding fume emission on a preweighed filter. Stop welding and sampling and reweigh the filter. Calculate the emission rate by dividing the mass of welding fume collected on the filter by the sampling time.

6.3.2 Equipment without filter cleaning system

Select the test arrangement and set up the test conditions.

— Determine the source emission rate as described in 6.3.1.

— Switch on the welding fume separation equipment, the air volume flow rate measurement systems and the air mover in the downstream measurement duct. Adjust the air volume flow rate in the upstream duct using the dampers to the air volume flow rate stated by the manufacturer.

— Monitor the air volume flow rate throughout the test.

— Generate and separate welding fume for an arcing period of 30 min without measurement in order to precondition the separation equipment. Use precoated filters to test equipment with mechanical separation systems, if the manufacturer intends their use.

— Commence sampling and collect samples of welding fume for an arcing period of 30 min.

— Continue welding for a further arcing period of 60 min without measurement (see Figure 3) and record the air volume flow rate at the end.

— When the test is completed, repeat the determination of the source emission rate and average the results of the first and second emission rate determinations. The average value should be 10 mg/s ± 2 mg/s.

