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Health and safety in welding and allied processes — Requirements, testing and marking of equipment for air filtration —

Part 3: **Determination of the capture efficiency of on-gun welding fume extraction devices**

Hygiène et sécurité en soudage et techniques connexes — Exigences, essais et marquage des équipements de filtration d''air —

Partie 3: Détermination de l'efficacité de la prise des appareils d'extraction des fumées de soudage

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/44/SC 9.

A list of all parts in the ISO 15012- series can be found on the ISO website.

Introduction

Welding generates fumes and gases which, if inhaled, can be harmful to human health. Therefore, control of the fume and gases must be exercised to minimise worker exposure.

The most effective method of welding fume control is local exhaust ventilation (LEV) which captures the fumes at source before they enter the general environment and the breathing zone of workers.

One form of LEV used in welding is on-torch extraction in which the extraction system is either an integral part of the welding torch or is attached to it close to the arc area. Anecdotal evidence within the fabrication industry suggested that it is impossible to capture fume efficiently whilst maintaining weld metal integrity but research (see bibliography[[4]]) has shown this not to be the case, certainly as far as weld metal porosity is concerned.

This part of EN 15012 prescribes a method for measuring the capture efficiency of on-torch extraction systems. The procedure only prescribes a methodology, leaving selection of the test parameters to the user, so that the effect of different variables may be evaluated.

It has been presumed in the drafting of this standard that the executions of its provisions and the interpretation of the results obtained are entrusted to appropriately qualified and experienced people.

Health and safety in welding and allied processes — Requirements, testing and marking of equipment for air filtration —

Part 3: Determination of the capture efficiency of on-gun welding fume extraction devices

1 Scope

This part of ISO 15012 defines a laboratory method for measuring the welding fume capture efficiency of on-torch extraction systems. It is applicable to integrated on-torch systems and to systems where a discrete extraction system is attached to the welding torch close to the arc area. The methodology is suitable for use with all continuous wire welding processes, all material types and all welding parameters.

The method can be used to evaluate the effects of variables such as extraction flow rate, extract nozzle position, shielding gas flow rate, welding geometry, welding torch angle, fume emission rate etc. on capture efficiency.

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 15767, *Workplace atmospheres — Controlling and characterizing uncertainty in weighing collected aerosols*

ISO/IEC Guide 98, *Uncertainty of measurement — All parts*

3 Terms and definitions

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

3.1
test chamber
semi-enclosed extracted chamber in which welding fume capture efficiency testing is performed

3.2
isokinetic sampler
device for collecting aerosol samples at the same velocity as the air being sampled

3.3
test chamber sampling duct
duct between the test chamber and an extraction fan in which all the fume generated can be collected or sampled isokinetically

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

Note 1 to entry: Emission rate is expressed in mg/s.

4 Principle

Automatic welding is performed using the on-torch extraction torch under test, on a test piece, inside a continuously extracted test chamber. Testing is carried out using identical welding parameters with and without the on-torch extraction activated. The ratio of measurements in the test chamber sampling duct is used to calculate the capture efficiency of the on-torch extraction torch.

Three methods of measuring the fume can be used. Two methods employ gravimetric measurement. The first method measures the total fume generated whilst second method employs isokinetic sampling in the test chamber sampling duct. The third method employs a direct reading measuring technique in the test chamber sampling duct.

5 Test equipment and materials

5.1 General requirement

The test setup shall enable containment of the fume generated in the arc area within the test chamber whilst ensuring the air velocity in the welding area below the torch does not exceed 0,2 m/s without welding and with the on-torch extraction off. See also B.1.

NOTE It is possible that not all of the fume generated by spatter production will be contained within the test chamber.

5.2 Test chamber

A continuously extracted chamber of sufficient dimensions to enclose the welding operation. Either the chamber shall be constructed of materials that will withstand close proximity to the heat and spatter generated by the welding or the chamber shall be designed so that the materials used are sufficiently distant from the arc to avoid problems arising from heat and spatter generation. See Figures A.1 and A.2.

Compliance with the requirements of clause 5.1 shall be verified.

5.3 Isokinetic samplers

The sample flow rate shall be such that the velocity through the sample inlet is the same as the surrounding air velocity. This ensures that the particle size distribution is unaffected by the sampling process and therefore the sample represents the particles present in the sampling duct. See also C.3.

5.4 Total fume and isokinetic filters

Filters, manufactured from glass or quartz fibre, with particle retention properties down to approximately 1 µm to 2 µm. The filters shall not tear or perforate during testing (see B.3) and shall not be so friable that fibres can be lost from the filters during handling.

Filters shall be treated according to the procedures defined in ISO 15767.

5.5 Extraction fan

The extraction fan for the sampling chamber shall be capable of maintaining a constant flow rate (± 2 %) in the test chamber sampling duct during testing when using during testing with iso-kinetic sampling or direct reading equipment.

The air flow generated by the fan shall be capable of retaining the entire fume generated within the test chamber.

5.6 On-torch extraction unit

The on-torch extraction unit shall be capable of maintaining a constant flow rate (± 2 %) in the on-torch extraction line during testing.

5.7 Equipment for measuring welding current, welding voltage, wire feed speed and arcing time

Equipment capable of measuring the current, voltage, wire feed speed and the arcing time within ± 1% . Electronic integrating equipment with frequent sampling intervals and a logging capability is recommended. See also Annex D.

In the absence of such equipment, current may be measured using a shunt or a Hall Effect probe connected to a moving coil meter. Voltage may be measured using a moving coil meter. Wire feed speed may be determined by measuring the length of wire exiting the welding torch in a measured time. The calibration of the equipment shall be traceable to national standards.

5.8 Equipment for direct-reading of fume concentration

The equipment shall have a reading that is directly proportional to the concentration with a maximum linearity error of 5% over the expected concentration range.

NOTE Equipment suitable for direct-reading of fume concentration is described for example in CEN/TR 16013.

5.9 Equipment for measuring the mass of fume collected

A balance, capable of measuring the mass of isokinetic sample filters and isokinetic sample filters plus fume with an accuracy of ± 0,01 mg or better.

A balance, capable of measuring the mass of total fume collection filters and total fume collection filters plus fume with an accuracy of ± 1 mg or better.

The balance calibrations shall be traceable to national standards.

5.10 Equipment for measuring shielding gas volume flow rate

Equipment calibrated for the shielding gas in use, capable of measuring the volume flow rate to within ± 5% or better. See B.4.

The calibration of the equipment shall be traceable to national standards.

5.11 Device for automatic welding

A device that permits the capture efficiency test to be performed under automated conditions, capable of advancing the test piece under a stationary welding torch at an appropriate rate (welding speed). It shall be possible to secure the test piece to the device, such that it cannot bow during welding.

5.12 Device for measuring contact tip to workpiece distance (CTWD)

A gauge, made by machining a metal block to a thickness equivalent to the required CTWD to within ± 5% or better, or a metal wedge with distance markings at appropriate points.

5.13 Device for measuring static pressure

A device capable of measuring static air pressure in the on-torch extraction line with an uncertainty of measurement not exceeding ± 1% of the reading, traceable to national standards. See B.8.

5.14 Device for measuring the mass flow rate

A device for measuring the mass flow rate to an accuracy of ± 5 % or better, traceable to national standards (e.g. according to EN ISO 5167). See B.9.

5.15 Materials

The same batch of filler wire and test pieces shall be used for each test series.

Test pieces, of a material and dimensions that are suitable for the capture efficiency test to be carried out, that allow a weld of sufficient length to be continuously deposited. See B.6.

6 Test procedure

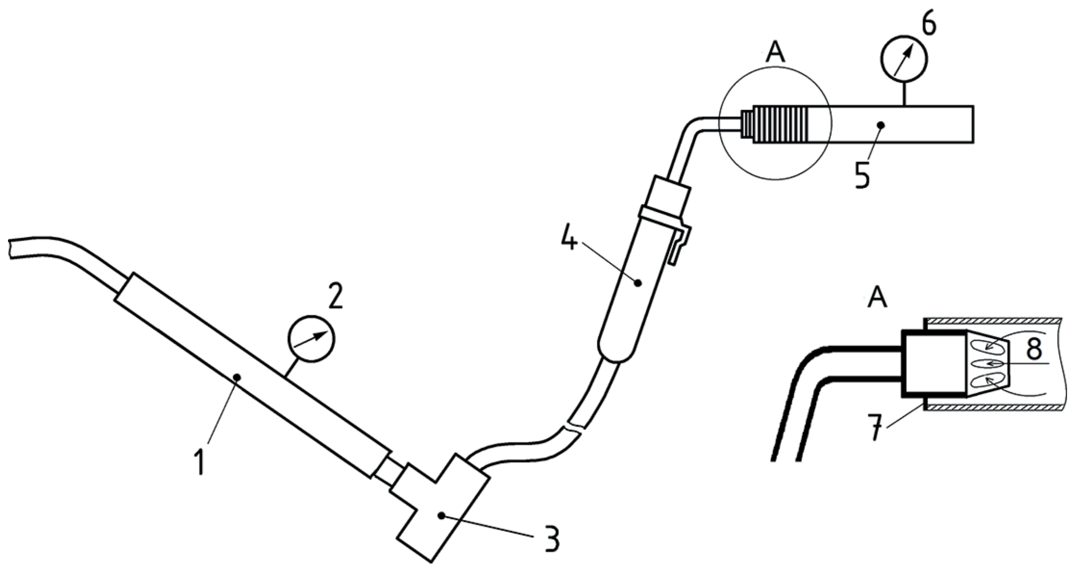
6.1 Preliminary tests

6.1.1 Setting the shielding gas flow rate

Set the shielding gas flow rate using the equipment described in 5.10.

6.1.2 Measuring the flow rates and determination of leakage

Measure the mass flow rate at two points shown in Figure 1, without welding, by using appropriate devices and calculate the air volume flow rate. See also B.7 and Annex H.



Key

1 device to permit mass flow rate measurement at extraction inlet on the connector of the torch

2 measurement point of the mass flow rate at the connector $Q_{m\ connector}$

3 connection between the torch and the extraction system

4 on-torch extraction torch

5 device to permit mass flow rate measurement at extraction inlet on the torch (see B.9)

6 measurement point of the mass flow rate at the nozzle $Q_{m\ nozzle}$

7 sealing

8 airflow

Figure 1 — - Points for measuring the flow rate

The leakage ratio is $\frac{Q_{m\ connector} - Q_{m\ nozzle}}{Q_{m\ connector}}$

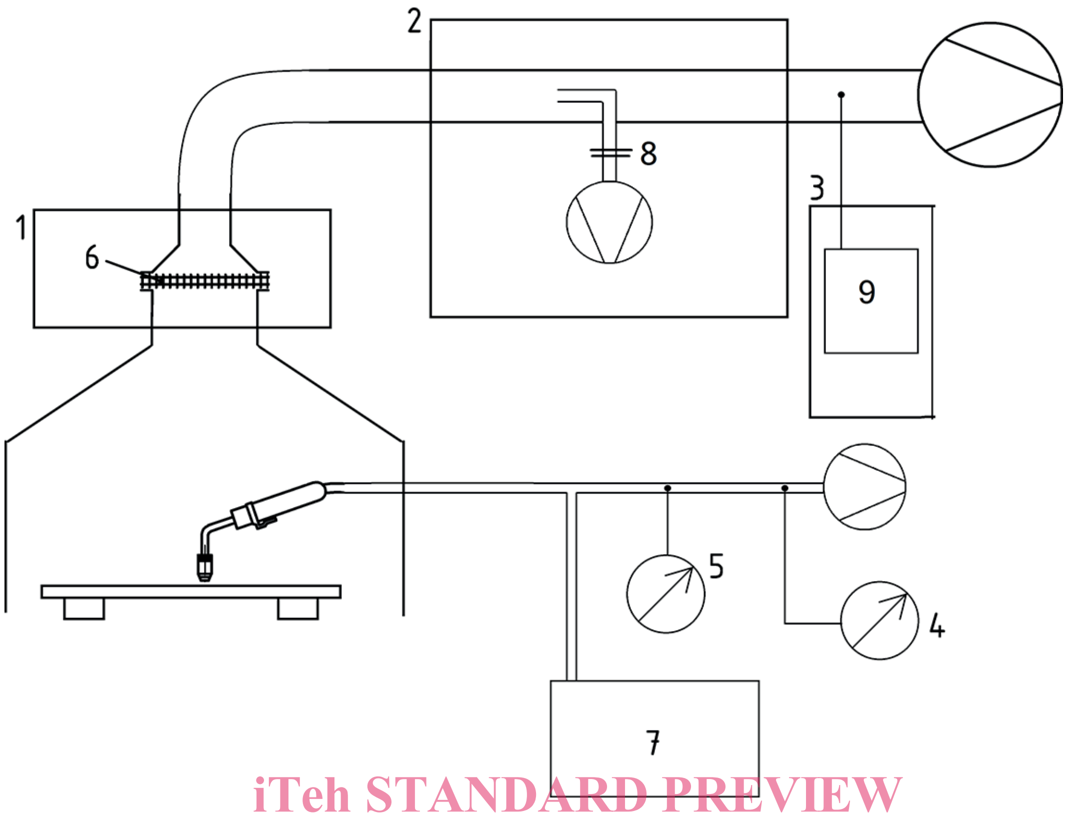
From mass flow rates ($Q_{m\ nozzle}$ and $Q_{m\ connector}$), the volume flow rates ($Q_{v\ nozzle}$ and $Q_{v\ connector}$) are calculated with the theoretical conditions of temperature and pressure of 20 °C and 101 325 Pa (1 013,25 hPa):

$$Q_v = \frac{Q_m}{\rho}$$

where ρ is the air density at 20 °C = 1,204 kg/m^3.

6.2 Setting up the test equipment

Set up the test equipment as shown in Figure 2, in an interference-free environment (see B.10).



Key

1 Method 1 (total mass measurement), according to Table 1
2 Method 2 (isokinetic sampling with a weighed filter), according to Table 1
3 Method 3 (direct reading in the duct or after isokinetic sampling), according to Table 1
4 flowrate measurement
5 static pressure measurement
6 total fume filter
7 welding unit
8 sample filter
9 direct reading instrument

Figure 2 — - Setup for the different measurement methods

6.3 Capture efficiency tests

6.3.1 General

Before starting the capture efficiency test, make sure that all welding conditions and flow rates are set to the desired values by performing trial tests. Guidance on performing trial tests is given in Annex C.

6.3.2 Test procedure

The steps for carrying out the three different test methods are given in Table 1. For the setup for the different measurement methods see Figure 2.