INTERNATIONAL STANDARD

ISO 15011-1

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Health and safety in welding and allied processes — Laboratory method for sampling fume and gases generated by arc welding —

Part 1: Determination of emission rate and sampling for analysis of particulate fume

Hygiène et sécurité en soudage et techniques connexes — Méthode de laboratoire d'échantillonnage des fumées et des gaz émis par le soudage à l'arc —

Partie 1: Détermination du taux d'émission et échantillonnage pour l'analyse des poussières

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15011 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15011-1 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 15011 consists of the following parts, under the general title *Health and safety in welding and allied processes — Laboratory method for sampling fume and gases generated by arc welding*:

— *Part 1: Determination of emission rate and sampling for analysis of particulate fume*

— *Part 2: Determination of emission rates of gases, except ozone*

— *Part 3: Determination of ozone concentration using fixed point measurements*

Annexes A to D of this part of ISO 15011 are for information only.

Contents

Foreword

This document (EN ISO 15011-1:2002) has been prepared by Technical Committee CEN/TC 121 "Welding", the secretariat of which is held by DS, in collaboration with Technical Committee ISO/TC 44 "Welding and allied processes".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2002, and conflicting national standards shall be withdrawn at the latest by October 2002.

This standard consists of the following parts:

— Part 1: Determination of emission rate and sampling for analysis of particulate fume;

— Part 2: Determination of emission rates of gases and vapours, except ozone;

— Part 3: Determination of ozone concentration using fixed point measurements.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard : Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Welding and allied processes produce particulate fume and gaseous by-products which may be harmful to human health. A knowledge of the quantity of particulate fume and gases generated and the composition of the particulate fume may be useful for occupational hygienists in accessing workplace atmospheres. Emission rates cannot be directly related to fume concentrations existing in a welder's breathing zone, but processes with low emission rates are supposed to produce less fume concentration compared with high emission rates for the same welding condition.

The laboratory procedure described in Part 1 of this standard is used to determine emission rate of particulate fume generated by the arc welding and provides a method of sampling the fume for chemical analysis. The emission rate and composition of particulate fume depend on the welding process, welding parameters, workpiece surface, coatings etc.

With the aid of a fume box in an un-polluted atmosphere, the total particulate fume generated during welding is collected and sampled on a filter in order to determine the emission rate and/or chemical composition.

1 Scope

This European standard describes a method for the determination of the particulate fume emission rate from arc welding processes using a fume box technique. It defines a method of sampling particulate fume for chemical analysis and suggests possible analytical techniques in order to characterize fumes emitted by consumable during welding.

2 Terms and definitions

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

2.1
fume box
a closed or semi-closed ventilated chamber used for sampling and determination (emission rate and composition) of fume and gases in welding and allied processes

2.2
test piece
piece of metal on which the welding process is performed

2.3
arc time
arc time starts from arc initiation and stops immediately as the arc is extinguished

3 Test equipment

3.1 Fume box

The fume box should consist of a top section containing a filter, a welding chamber and a chamber base. The welding chamber shall be large enough to allow complete capture of the emitted fume. The fume box should be designed to reduce deposition of welding fume onto the internal box surface. Examples of possible arrangements are described in annex A, as an example. Other appropriate fume box designs may be used.

3.2 Filters

The filters shall be capable of withstanding the pressure drop and shall allow collection of fume loadings between 0,4 mg/cm² and 1,2 mg/cm². The filters shall have a minimum efficiency of 99,5 %.

NOTE Practically, to avoid clogging of the filter, such values require the use of filters with a diameter of approximately 250 mm.

For determination of emission rate, weight stability with respect to humidity is essential and glass fibre filters or quartz filters are recommended. If a fume sample is collected for chemical analysis the type of filter should be such that it is free from relevant contaminants and compatible with subsequent analysis procedures. A paper filter (cellulose) is recommended.

For the determination of hexavalent chromium, the fumes shall be removed immediately from the filter.

The filters are held by a stainless steel wire mesh; recommended dimensions for the mesh size are 0,5 mm to 2,0 mm.

The filter holding device shall allow the filter to be removed and there shall not be any leakage between the filter and its support.

3.3 Pump

The precise characteristics of the pump are not considered to be critical providing the flow is adequate to contain the fume within the box without interfering with the welding process and to clear the fume box of fume after completion of welding, within the time specified, see 6.5.

The pump shall have a suction characteristic able to give:

— at the beginning of the test a flow rate of 25 l/s to 30 l/s at 10000 Pa (0,1 bar) which corresponds to the resistance of the filter at 0 mg fume;

— at the end of the test, a flow rate of at least 5 l/s at 16000 Pa to 20000 Pa.

3.4 Measuring equipment

Voltage measurements across the arc and welding current shall be measured using electrical recorders with an accuracy class of 0,5.

The arc time shall be measured with a timer having increments of 0,1 s or smaller.

The mass of collected particulate matter shall be measured using a balance with a sensitivity of at least 1 mg.

4 Test pieces

All details concerning the test piece shall be noted in the test report (see annex B).

The choice of the test piece shall be appropriate to the welding process, the consumable and the welding conditions being used.

5 Consumable

All details concerning the consumable shall be noted in the test report (see annex B).

The choice of the consumable shall be appropriate to the welding process, the test piece and the welding conditions being used.

6 Procedure

6.1 Principle

A weld is made inside the fume box while the pump is running. The fume produced is collected on the filter.

6.2 Test sequence

The test sequence shall be as follows:

— a test piece shall be placed directly on the metallic table inside the fume box;

— a weighed filter shall be placed in the sampling device;

— the pump shall be switched on.

During welding:

— arc time shall be measured (see 2.3);

— suction shall be maintained at least for 30 s after arc extinction;

— the filter shall be immediately withdrawn and reweighed;

— for analysis, the collected particulate fumes should be removed from the filter immediately and stored in an airtight glass bottle.

6.3 Precautions

Before beginning a test, ensure that the inside surface of the fume box and the test piece have been cleaned, that both are at ambient temperature and that the chamber box is free of spatter.

Filters shall be handled with care and not soiled before or after the test with dust or grease from the fingers.

The test is only valid if:

— no fume escapes from the box;

— the temperature of the welding chamber does not become high enough to allow the deposition of the fume onto the internal box surface.

6.4 Welding parameters

All welding parameters shall be noted in the test report (see annex B).

The parameters shall be kept constant during each measurement and for each test.

6.5 Duration of the test

The test is continued until at least 0,1 g of fume is collected and shall be stopped before clogging of the filter.

Pre-tests allow determination of the welding time.

7 Interpretation of results

7.1 Number of tests

To evaluate the emission rate three tests are made and the mean value is calculated. If the individual results differ by more than ± 10 % of the mean, two more tests shall be made and the mean value of the five results calculated.

7.2 Calculation of fume emission rate

The fume emission rate, E, (expressed in milligrams of particulate fume per second of welding time) is calculated as follows:

$$E = \frac{M_2 - M_1}{t}$$

where

M_1 is the mass of the filter before welding in milligrams (mg);

M_2 is the mass of the filter after welding in milligrams (mg);

t is the arc time in seconds (s) .

7.3 Analysis

Elements to be analysed are dependent on the welding process and the consumable.

The recommended techniques are given in annex C.

Total hexavalent chromium is analysed after extraction according to the method given in annex D.

The analysis shall provide sufficient information to enable compliance with national health and safety regulations to be established.

7.4 Recording of test data and presentation of results

It is necessary to record complete information about the welding operation, since the choice of welding parameters can greatly influence the amount of fume produced. An example of a test report is given in annex B.

Annex A
(informative)

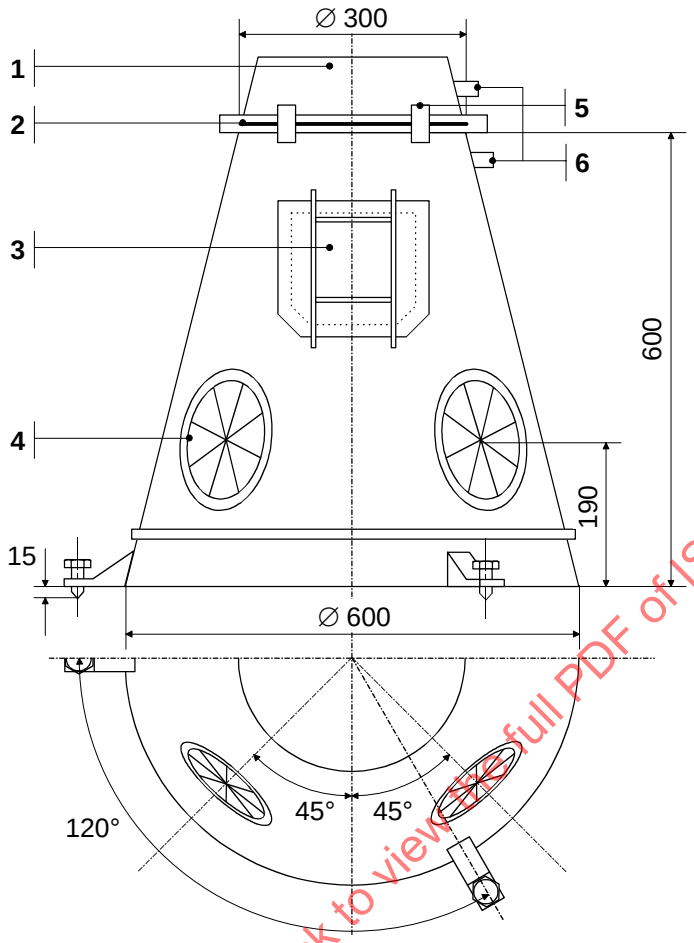
Possible designs of fume boxes designed for manual metal arc welding, MIG-welding and MAG-welding

A.1 Design 1

Particulate fume collection can be achieved by means of a conical welding chamber (see Figure A.1) : base diameter 600 mm, height 600 mm, upper part and filter diameter 300 mm.

This chamber is provided with two hand-holes with rubber strips so that the welder can work from the outside. A large viewing window with a protection filter provides visibility to examine and guide the arc during welding. The chamber base may be simply made with three legs allowing the welding chamber to be 15 mm above the surface on which it stands. The top section may be a cylinder fixed on the welding chamber at the level of the filter and connected to the suction system.

Dimensions in millimetres



Key

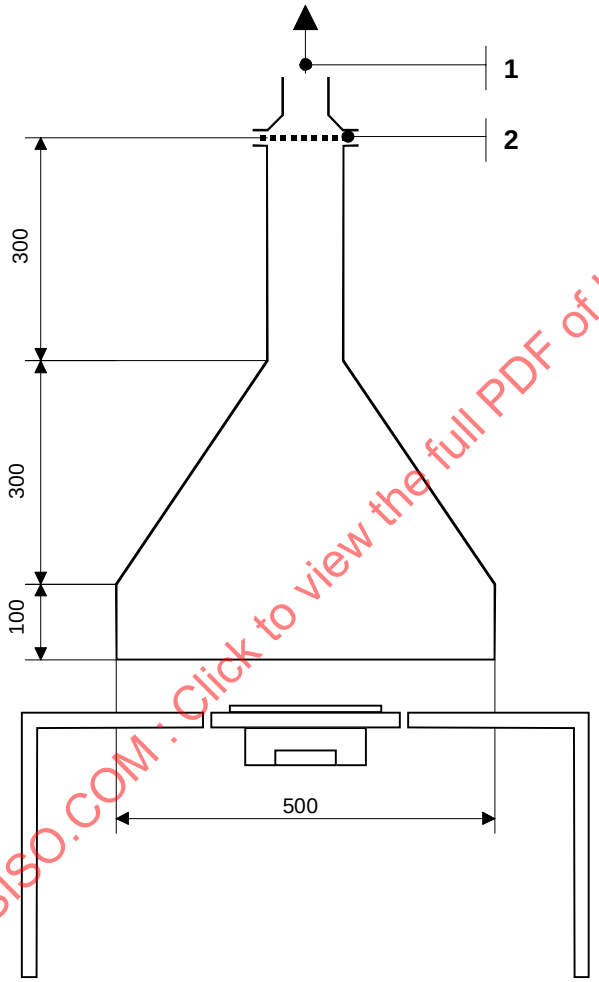
1 Towards the suction system
2 Filter
3 Protection filter
4 Holes for hands and electrode holder or welding torch
5 Clamping lock system
6 Couplings for the measure of load loss

Figure A.1 - Fume box

A.2 Design 2

The suggested fume box design features are shown in Figure A.2. The fume box consists of a pyramidal test chamber with a bottom skirt. The chamber base dimensions are 500 mm x 500 mm, skirt height 100 mm and pyramid height 300 mm (total height of the welding chamber 400 mm). A 200 mm diameter stack, 300 mm high is fitted to the top of the welding chamber. A filter assembly for collecting the total fume is mounted at the top of the stack and connected to a pump unit. The total height of the filter assembly above the base is approximately 700 mm.

Dimensions in millimetres



Key

1 Towards the suction system

2 Filter

Figure A.2 - Fume box

Annex B
(informative)

Test report

Table B.1 — Test results

Date of test	Operator				Ref.	
Process Welding position					Type of fume box	
Consumable	Manufacturer/brand name Consumable name Batch Diameter Remarks				Standard	
Test piece	Base metal Dimensions Surface conditions Remarks				Standard	
Shielding gas	Trade name Composition Flow rate Remarks				Standard	
Welding and monitoring equipments	Power source: Trade mark and complete type Recording equipment					
Measurement details	Test 1	Test 2	Test 3	Test 4	Test 5	Units
Welding : manual/mechanized						
Arc voltage – Polarity						V/DC(+)DC(-)AC
Arc current						A
Pulsing details (where applicable)						
Wire feed speed (where applicable)						m/min
Stick out (where applicable)						mm
Welding speed						cm/min
Remarks						
Arc time						s
Filter weight						mg
after test						mg
before test						mg
Particulate fume weight						
Mean value of emission rate						mg/s
Welding fume composition of elements						%(m/m)
Other remarks:						