INTERNATIONAL STANDARD

ISO 29042-3

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Safety of machinery — Evaluation of the emission of airborne hazardous substances —

Part 3: Test bench method for the measurement of the emission rate of a given pollutant

Sécurité des machines — Évaluation de l'émission de substances dangereuses véhiculées par l'air —

Partie 3: Méthode sur banc d'essai pour le mesurage du taux d'émission d'un polluant donné

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 29042-3 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

ISO 29042 consists of the following parts, under the general title *Safety of machinery — Evaluation of the emission of airborne hazardous substances*:

— *Part 1: Selection of test methods*

— *Part 2: Tracer gas method for the measurement of the emission rate of a given pollutant*

— *Part 3: Test bench method for the measurement of the emission rate of a given pollutant*

— *Part 4: Tracer method for the measurement of the capture efficiency of an exhaust system*

The following parts are under preparation:

— *Part 5: Test bench method for the measurement of the separation efficiency by mass of air cleaning systems with unducted outlet*

— *Part 6: Test bench method for the measurement of the separation efficiency by mass of air cleaning systems with ducted outlet*

— *Part 7: Test bench method for the measurement of the pollutant concentration parameter*

A room method for the measurement of the pollutant concentration parameter and a decontamination index are to form the subjects of future parts 8 and 9.

Introduction

The structure of safety standards in the field of machinery is as follows:

a) type-A standards (basic safety standards) giving basic concepts, principles for design, and general aspects that can be applied to all machinery;

b) type-B standards (generic safety standards) dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:

- type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

- type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure-sensitive devices, guards);

c) type-C standards (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This part of ISO 29042 is a type-B standard as stated in ISO 12100-1.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines which are covered by the scope of a type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

ISO/TC 199 has a mandate in this area to produce type-A and type-B standards, which will allow verification of conformity with the essential safety requirements.

ISO 29042-3 is based on EN 1093-3:2006, amended by Amendment 1:2008, published by the European Committee for Standardization (CEN).

Safety of machinery — Evaluation of the emission of airborne hazardous substances —

Part 3: Test bench method for the measurement of the emission rate of a given pollutant

1 Scope

This part of ISO 29042 specifies a test bench method for the measurement of the emission rate of a given airborne hazardous substance from a machine using a test bench under specified machine operating conditions.

The measurement of the emission rates of a given pollutant emitted from machines can serve for

a) evaluation of the performance of a machine,

b) evaluation of the reduction of pollutant emissions of a machine,

c) comparison of machines within groups of machines having the same intended use (as defined by the function and materials processed),

d) ranking of machines from the same group according to their emission rates, and

e) determination of the state-of-the-art of machines with respect to their emission rates.

This part of ISO 29042 is not applicable to machinery manufactured before the date of its publication.

2 Normative references

The following referenced documents are indispensable for the application 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 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100-1 and the following apply.

3.1
uncontrolled emission rate of a given pollutant
$\dot{m}_u$
mass of pollutant emitted from the machine into the space around the machine per unit of time

NOTE Any measures to reduce the air pollution around the machine (e.g. capture devices, containment equipment, wetting process) should not be used or should be de-activated.

[ISO 29042-1:2008, definition 3.1]

3.2
controlled emission rate of a given pollutant
$\dot{m}_k$
mass of pollutant emitted from the machine into the space around the machine per unit of time, taking into account the effects of measures to reduce the air pollution

NOTE Any measures to reduce the air pollution around the machine (e.g. capture devices, containment equipment, wetting process) should be used or activated.

[ISO 29042-1:2008, definition 3.2]

4 Principle

The principle of the measurement method is the operation of the machine under controlled conditions and with a uniform air flow on a test bench, and to collect a representative part of the airborne emissions in that air flow.

5 Description of the test bench

The test bench consists generally of a test cabin with a funnel and a measurement duct, of rectangular or circular cross-section, followed by a fan (see Figure 1). It is the responsibility of the type-C standard committees to select parameters within the ranges given in Figure 1.

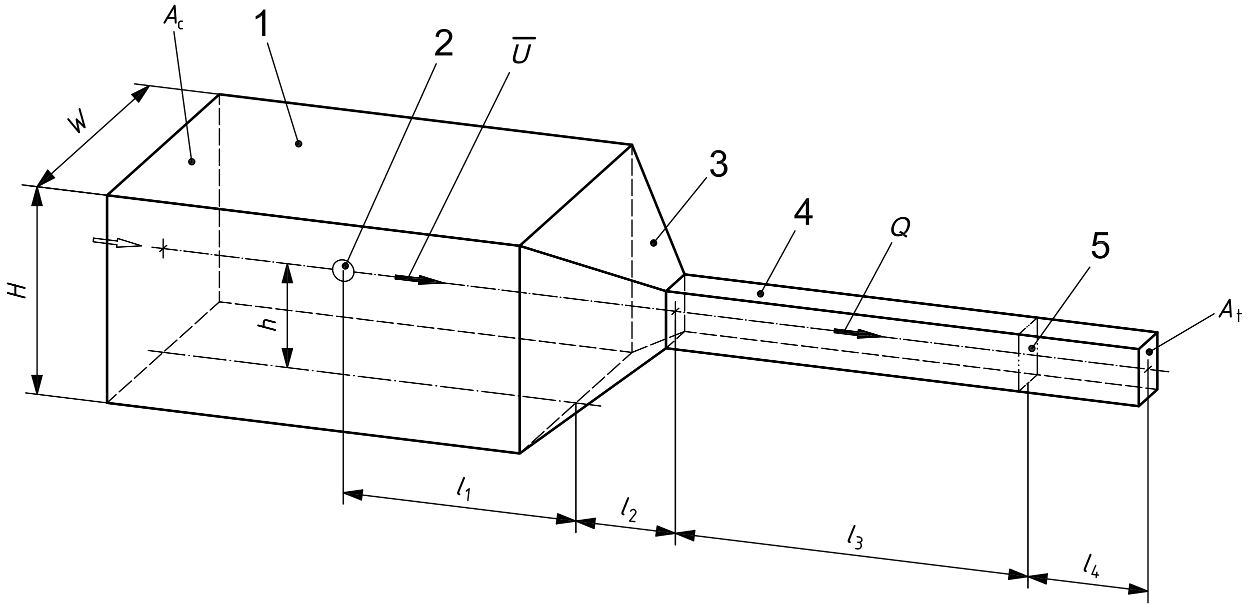
The fan produces an air flow in the test cabin from the inlet towards the funnel. The test cabin should be equipped with an inlet that ensures that the air entering the test cabin has a uniform velocity profile across the test cabin cross-section. This can be achieved in a number of ways, including by means of macroporous filter material, perforated plastic foil or plate, or a profiled inlet associated with an undisturbed air flow pattern in the test hall.

The selected average air velocity, $\overline{U}$, in the test cabin between the source and the funnel (see Figure 1) is determined by the air volume flow rate, Q, in the measurement duct. The system requires controls to ensure that a constant flow rate is maintained during testing. This air flow rate does not include the air flow rate caused by the operation of the capture device (where used) of the machine under test.

The cross-section of the test cabin (form and dimensions) is chosen according to the size of the test object. The maximum cross-sectional area of the test object shall not exceed a fifth of the cross-sectional area of the test cabin, A_c.

A small axial fan is positioned in the funnel to mix the pollutant emitted from the machine in order to ensure more accurate sampling of the pollutant in the measurement duct. Other mixing devices, e.g. compressed air nozzles, can be used providing they give a similar degree of uniformity of the concentration profile at the sampling plane.

The test cabin shall be long enough to accommodate the machine and the operator with the emission sources as close as practicable to the location specified in Figure 1.



$W/H \geqslant 0{,}66$	$l_3 \geqslant 5\sqrt{A_t}$	
$\leqslant 1{,}5$	$\leqslant 10\sqrt{A_t}$	
$h \leqslant 0{,}66H$	$l_4 \geqslant 3\sqrt{A_t}$	
$l_1 \leqslant 2{,}0$ m	$A_t \leqslant 0{,}1\,A_c$	
$\leqslant 2H$	$\geqslant 5\,A_{mi}$	
$l_2 \geqslant 0{,}5\sqrt{A_c}$	$\overline{U} = 0{,}1\ \text{m}\cdot\text{s}^{-1}$	for gases and respirable fraction particles according to ISO 7708
$\leqslant \sqrt{A_c}$	$\overline{U} = 0{,}5\ \text{m}\cdot\text{s}^{-1}$	for inhalable fraction particles according to ISO 7708

Key

A_c cross-sectional area of test cabin (inlet)
A_t cross-sectional area of measurement duct
H height of test cabin
h height of emission source
$\overline{U}$ average air velocity in test cabin
Q measured air flow rate
W width of test cabin
mi subscript denoting measuring instrument

1 test cabin
2 emission source [a]
3 funnel
4 measurement duct
5 sampling plane

The value of the average air velocity, $\overline{U}$, shall be chosen to enable the emitted pollutants to be transported from the machine to the sampling plane. For gases and small particles (e.g. respirable particles, welding fume) an average air velocity of 0,1 m·s^{-1} is sufficient, whilst for the larger particles within the inhalable fraction an average air velocity of 0,5 m·s^{-1} is required (see Reference [1]). Lower velocities may be used providing reliable surface deposition measurements are also carried out.

[a] Generally, the emission source cannot be considered as a point, but as a zone including several sources.

Figure 1 — Test bench (schematic layout)

6 Test method

6.1 Position of the machine

To ensure that all the pollutant will be carried to the sampling plane, in as far as this is possible, the machine should be positioned in the test cabin so that

— the source of the hazardous substance emitted from the machine is in the area of the transverse plane to the longitudinal axis of the test cabin at a distance of l_1 from the beginning of the funnel, and

— the operator and additional equipment (e.g. exhaust, separation or wetting devices) are not between the source and the sampling plane.

6.2 Operation of the machine

The machine shall be operated according to its intended use. The stipulation of working procedures, the tools used and the materials to be processed with specified categories of machines will be defined in type-C standards.

If the cleaned air from a separator linked to the machine according to the intended use is re-circulated, the outlet of the separator shall be located in the test cabin in such a way as to ensure that the pollutant from this secondary source reaches the measurement duct.

The machine shall be operated taking into account the instructions of the manufacturer. When the machine is provided with a pollutant control system, this shall be adjusted according to those instructions.

Tests shall not be carried out without the manufacturer's specifications for operating the pollutant control system.

At least three tests shall be performed.

6.3 Sampling plane and measurement procedures

The concentrations of the airborne pollutants are measured at the sampling plane in the measurement duct (see Figure 1) for the period of the test. The procedure used for concentration and flow rate measurements shall comply with an appropriate International Standard, where available. An efficient mixing of the pollutant and a minimum of four samplers are required to ensure a representative measurement of the mean concentration of pollutant passing the sampling plane.

NOTE In an EU-funded project, five samplers was found to be the optimum number[1].

The use of a mixing device as specified in Clause 5 will always be necessary, even for gaseous pollutants.

The measurement of particles shall take into account the size fraction of interest. The sampling shall be carried out isokinetically. When emission rates are expected to be low, very long operating times are required to collect enough dust to weigh. To reduce the operating time, suitable direct reading instruments should be used. These should preferably measure mass directly or should be calibrated for the specific dust emitted from the machine.

The measurement time shall be sufficient to collect concentration data representative of the normal operational cycles of the machines. The concentration data to be processed for the determination of the emission rates (average values, peak values) are specified in the relevant type-C standards. If a type-C standard is not available, the test conditions shall be recorded in the test report.

The measurement shall continue beyond the end of pollution generation for sufficient time as to allow the remaining airborne pollutants to pass through the sampling plane.

7 Expression of results

The emission rates are calculated by Equations (1) and (2):

$$\dot{m}_u = \frac{1}{t_2 - t_1} Q \int_{t_1}^{t_3} C_u \mathrm{d}t \qquad (1)$$

$$\dot{m}_k = \frac{1}{t_2 - t_1} Q \int_{t_1}^{t_3} C_k \mathrm{d}t \qquad (2)$$

where

C_u is the pollution concentration measured in the air flow in the measurement duct with the pollutant control system not in use or de-activated;

C_k is the pollution concentration measured in the air flow in the measurement duct with the pollutant control system in use or activated;

Q is the measured air volume flow rate in the measurement duct;

t_1 is the starting point of the test;

t_2 is the end of the pollutant generation;

t_3 is the end of sampling.

The emission rate is the mean value of the results of several tests.

NOTE The emission rate measured is for the airborne pollutants only. For particles, especially large ones, there is an appreciable mass of particles that deposits on the internal surfaces of the test cabin before reaching the sampling plane. The measurement can either be added to the airborne emission rate to give a total mass of dust emitted, or can be used to represent those particles that would deposit on surfaces in the factory workshop.

8 Test report

The test report shall include at least the following information:

a) reference to this part of ISO 29042 (“ISO 29042-3:2009”) and to any associated type-C standard(s);

b) description of the machine tested (manufacturer, model, type, version, design, size, year of manufacture, serial number, etc.) — for the machine itself and for each additional piece of equipment);

c) operational data during tests including tools used with the machine and material processed on the machine;

d) description of the pollution control system (type, design, operational data, etc.), if fitted;

e) description of the measurement procedures and pollutant measured;

f) measuring instruments used and their most recent calibration date;

g) test results;

h) test laboratory;