SLOVENSKI STANDARD
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Načrtovanje ventilatorjev za delovanje v potencialno eksplozivnih atmosferah

Design of fans working in potentially explosive atmospheres

Konstruktion von Ventilatoren für den Einsatz in explosionsgefährdeten Bereichen

Conception des ventilateurs pour les atmosphères explosibles

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Conception des ventilateurs pour les atmosphères explosibles

Konstruktion von Ventilatoren für den Einsatz in explosionsgefährdeten Bereichen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 305.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (prEN 14986:2014) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres - Explosion prevention and protection”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14986:2007.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Introduction

This European Standard is a type C standard as stated in EN ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered and indicated in the scope of this European Standard.

When provisions of this type C standard are different from those, which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

1 Scope

1.1 This European Standard specifies the constructional requirements for fans constructed to Group II G (of explosion groups IIA, IIB and hydrogen) categories 1, 2 and 3, and Group II D categories 2 and 3, intended for use in explosive atmospheres.

NOTE Operation conditions for the different categories of fans used in this European Standard are defined in Clause 4.

1.2 This European Standard does not apply to group I fans (fans for mining), cooling fans or impellers on rotating electrical machines, cooling fans or impellers on internal combustion engines.

NOTE 1 Requirements for group I fans are given in EN 1710.

NOTE 2 The requirements for electrical parts are covered by references to electrical equipment standards.

1.3 This European Standard specifies requirements for design, construction, testing and marking of complete fan units intended for use in potentially explosive atmospheres in air containing gas, vapour, mist and/or dusts. Such atmospheres may exist inside (the conveyed fluid), outside, or inside and outside of the fan.

1.4 This European Standard is applicable to fans working in the range of ambient atmospheres having absolute pressures ranging from 0,8 bar to 1,1 bar, temperatures ranging from -20 °C to +60 °C, maximum volume fraction of 21 % oxygen content and by the condition at the inlet (pressure ranging from 0,8 bar to 1,1 bar, temperatures ranging from -20 °C to +60 °C) and an aerodynamic energy increase of less than 25 kJ/kg.

NOTE 1 25 kJ/kg is equivalent to 30 kPa at inlet density of 1,2 kg/m³.

NOTE 2 This European Standard may also be helpful for the design, construction, testing and marking of fans intended for use in atmospheres outside the validity range stated above or in cases where other material pairings need to be used. In this case, the ignition risk assessment, ignition protection provided, additional testing (if necessary), manufacturer's marking, technical documentation and instructions to the user, should clearly demonstrate and indicate the equipment's suitability for the conditions the fan may encounter.

NOTE 3 This European Standard does not apply to integral fans of electric motors.

NOTE 4 Where undated references are used in the body of the standard the latest edition applies.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 294, *Safety of machinery — Safety distance to prevent danger zones being reached by the upper limbs*

EN 1127-1:2011, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 13463-1:2009, *Non-electrical equipment for potentially explosive atmospheres — Part 1: Basic method and requirements*

EN 13463-5, *Non-electrical equipment intended for use in potentially explosive atmospheres — Part 5: Protection by constructional safety "c"*

EN 13463-6, *Non-electrical equipment for use in potentially explosive atmospheres — Part 6: Protection by control of ignition source "b"*

EN 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*

EN ISO 11925, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame*

EN ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

EN ISO 16852:2010 , *Flame arresters — Performance requirements, test methods and limits for use*

ISO 13349:2010, *Fans — Vocabulary and definitions of categories*

ISO 14694:2003, *Industrial fans — Specifications for balance quality and vibration levels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1127-1:2011, EN 13463-1:2009 and the following apply.

3.1
externally mounted flame arrester
flame arrester with flame arrester housing and flame arrester elements mounted as a separate equipment on the fan

3.2
integrated flame arrester
flame arrester where flame arrester element only is part of the fan

3.3
contact diameter
diameter of a rotating part at the point where it can contact a stationary part

4 Requirements for all fans

4.1 General

All fans within the scope of this European Standard shall comply with the requirements contained in EN 13463-1 unless otherwise stated in this European Standard.

NOTE This European Standard deals only with the prevention of ignition of an explosive atmosphere by the fan. Other safety features will need to be incorporated into the construction to meet the requirements of other EU Directives. For example by incorporating the principles of EN ISO 12100 for preventing mechanical hazards, (e.g. guarding to prevent persons contacting rotating parts, sharp edges).

4.2 Ignition hazard assessment

4.2.1 General

A list of hazards which can occur is given in Annex D. Where additional hazards could occur an ignition hazard assessment according to EN 13463-1 shall be carried out.

For the purposes of fans made according to this European Standard the following operational conditions shall be used as a basis for the ignition hazard assessment and for the assignment of a fan to a particular category.

Release of flammable material shall be considered in the ignition hazard assessment for the outside of the fan, see 4.3.

4.2.2 Normal operating conditions

Normal operating conditions shall be considered to occur in situations where the fan performs its intended use within its design parameters. This includes conditions during start up and shut down. (See also EN ISO 12100.)

For the purposes of fans made according to this European Standard failures (such as a breakdown of seals, flange gaskets or releases of substances caused by accidents) which involve repair or shut-down are not considered to be part of normal operation.

4.2.3 Expected malfunction

An expected malfunction shall be considered to be a failure or fault in a fan which normally occurs in practice. In addition an expected malfunction shall be considered to occur when a fan or its components do not perform their intended functions.

For the purposes of fans made according to this European Standard this can happen for a variety of reasons, including:

a) variation in the properties or dimensions of the fan assembly (e.g. warping of the casing);

b) disturbance to or failure of the power supply or other services;

c) unnoticed long time operation with defective bearing and leading to contact between impeller and housing;

d) release of the impeller blade by vibrations over an extended period.

4.2.4 Rare malfunction

A rare malfunction is a type of malfunction which is known to happen but only in rare instances. Two independent expected malfunctions which, separately, would not create an ignition hazard but which, in combination, do create an ignition hazard, are regarded as a single rare malfunction.

4.3 Assignment of categories

A fan may have a different category for the inside and outside. Fans which may be used both to convey an explosive gas, vapour, mist or dust atmosphere and/or are located in an explosive gas, vapour, mist or dust atmosphere are assigned categories internally and externally depending on the likelihood of them acting as an effective ignition source.

Category 3 fans shall not be an effective ignition source in normal operation, see 4.2.2. Category 2 fans shall in addition not be an effective ignition source with expected malfunctions, see 4.2.3. Category 1 fans shall in addition not be an effective ignition source with rare malfunctions, see 4.2.4.

Fans, especially their shaft seals and flexible connections at the inlet and outlet, may not be absolutely gas tight, and connected ducts may not be leak proof. The hazardous atmosphere may leak either from the inside of the fan into the adjacent environment, or from a hazardous environment around a fan, and into the fan casing through a leakage path e.g., a shaft seal when this is below atmospheric pressure. Therefore the manufacturer shall consider these aspects in the ignition hazard assessment. The manufacturer shall give information about the possible leakage rates of the fan in the information for use.

Where the leakage rates are not known the manufacturer shall construct the fan so that there is no more than one category difference between the inside and the outside.

Where the fan has an open inlet and/or outlet (installation modes A, B, C according to ISO 13349) the inside and the outside of the fan shall have the same category.

4.4 Temperatures

4.4.1 General

Both the temperature of potentially hot surfaces and the temperature of the conveyed fluid and/or of the atmosphere surrounding the fan shall be considered.

4.4.2 Maximum surface temperature

The maximum surface temperature of the fan characterises the hottest part of the equipment that can come in contact with the explosive atmosphere or the maximum temperature of the conveyed fluid which can act as an ignition source.

The maximum surface temperatures of both the inside and outside parts of the fan that can come in contact with the explosive atmosphere shall be determined in accordance with EN 13463-1.

In addition, to that the maximum surface temperature marked for the inside of the fan shall be the greater of either:

— the maximum surface temperature determined in accordance with EN 13463-1 including the appropriate safety margins for the different categories, or

— the maximum temperature of the conveyed fluid at the outlet with a safety margin of 20 % (with temperatures measured in °C).

These temperatures are determined considering the highest inlet temperature specified in 4.4.3.

NOTE This increased safety margin of 20 % has been chosen because of the increased ignition rate at higher gas temperatures.

The maximum surface temperature of the equipment is used – after the application of the above safety margins – for marking of the equipment with a defined temperature, a temperature class of the equipment or an appropriate explosive atmosphere.

EXAMPLE A fan with the following parameters: The maximum surface temperature of the inside, measured according to EN 13463-1 with the appropriate safety margin is 90 °C, the temperature of the conveyed fluid measured at the outlet is 80 °C for an inlet temperature of 60 °C. With a 20 % safety margin the maximum outlet temperature is 96 °C. Therefore the maximum temperature marked for the inside of the fan is 96 °C.

4.4.3 Temperature of the conveyed fluid

While it is only the ambient and the inlet temperature which is generally known by the user, it is the normally higher outlet temperature which determines the suitability of the fan for the intended use.

As well as temperature increases during normal service, extraordinary temperature increases shall be considered.

In the absence of detailed information from the purchaser on expected fault conditions and maximum and minimum flow, pressure rise and density, the fan manufacturer shall ensure that the appropriate temperature limits are maintained between - 10 % or + 20 % of nominal gas flow, and at maximum and minimum expected densities. Generally maximum temperature rise will occur at minimum flow and maximum density. For variable speed fans the calculation shall be carried out at maximum fan speed and/or the speed which gives maximum fluid outlet temperature.

For fans with motor mounted in airstream consideration shall be given to the heating effect from the motor.

The manufacturer's instructions shall include the minimum and maximum air flow rates which are required to maintain the temperature rating.

The manufacturer shall measure or calculate the maximum gas temperature for an inlet gas temperature of 60 °C within the gas flow limits or - 10 % to 20 % of nominal gas flow.

Where the maximum inlet temperature is different from 60 °C, the manufacturer shall mark the fan appropriately.

NOTE Tests have shown that at gas temperatures above +60 °C ignition hazards increase considerably.

Electric motors and other temperature sensitive components shall receive special attention as they generally are designed for a maximum ambient temperature of +40 °C.

4.5 Mechanical design criteria

4.5.1 General

Fans for operation in potentially explosive atmospheres shall be of rigid design. This requirement is considered as fulfilled for casings, supporting structures, guards, protective devices and other external parts if the deformation resulting from an impact test at the most vulnerable point is so small that the moving parts do not come into contact with the casing. The test shall be carried out in accordance with EN 13463-1.

NOTE Foreseeable causes of reducing the clearances between the casing and the moving parts include distortion of the casing caused by connection to ductwork with no flexible joints, or by damage to the casing during installation, e.g. by dropping the fan. Reduction of the clearance is also possible if the fan is installed with inlet ductwork and the pressure drops below atmospheric when the inlet is closed.

All impellers, bearings, pulleys, cooling disks etc. shall be securely fixed in position.

The manufacturer shall specify the maximum loads that may be imposed on the casing from connecting ductwork.

The fan shall be capable of withstanding the lowest inlet pressure that can be generated by the fan itself when the inlet is closed, without causing contact between the casing and the moving parts.

This requirement shall not apply to the bearings incorporated within electric motors which shall be subject to the requirements specified in EN 60079-0.

4.5.2 Clearance between rotating elements and the fan casing

The clearance between rotating elements and the fan casing is the most important safety feature of ignition minimising fans. The minimum clearances between rotating parts such as the impeller and fixed parts e.g. the fan casing shall be at least 0,5 % of the relevant contact diameters (diameter of a rotating part at the point where it can contact a stationary part) of the finished component, but shall not be less than 2 mm in the axial or radial directions nor need be more than 13 mm. The design and construction shall ensure that the clearances are maintained under all conditions covered by the intended use. For shaft seal elements, see 4.15.

The manufacturer's instructions shall include where necessary the appropriate maintenance instructions to maintain the clearance.

NOTE 1 Minimum clearance is defined as taking into account all possible tolerances due to manufacture and fitting.

NOTE 2 The clearance may change with rotation, temperature, and due to vibrations and belt drive tension.

4.6 Casing

4.6.1 General

The fan casing shall be of a substantially rigid design, to satisfy the mechanical design requirements specified in 4.5.

Inspection doors and other openings are permitted, but must be designed to be substantially leak tight when properly closed.

4.6.2 Gas tightness

Where the casing is not continuously welded and tested for leaks, the manufacturer shall consider the possibility of leakage in the selection of components and equipment attached to the outside of the fan.

NOTE For example where flammable substances are being conveyed in a flanged construction, category 3 or 2, equipment is often required outside.

The manufacturer shall provide information to the user on possible leakage from the fan if a flammable substance or a gas mixture above LEL is to be conveyed or is present outside.

Gas leakage may come from the shaft seal, or joints in the casing. The shaft seal leakage rate may increase over time. The manufacturer shall provide information about maintenance requirements for the seals.

4.7 Impellers

Impellers shall be of a rigid design and shall be able to withstand a test run at a minimum of 1,15 times the maximum operational rotating speed for at least 60 s without causing an ignition risk, i.e. the impeller shall not contact the casing.

A continuously welded fabricated impeller or a cast moulded impeller, both having all elements of appropriate thicknesses and strength to ensure average calculated primary stresses less than 2/3 of the yield stress, shall be deemed to satisfy the requirements for a rigid design without testing.

4.8 Materials for rotating and stationary parts of fans

4.8.1 General

In view of possible friction, due to malfunctions or even rare malfunction, potential areas of contact between the rotating elements and fixed components shall be manufactured from materials in which the risk of ignition through friction and friction-impact sparks, hot spots or hot surfaces is minimised. Consideration should be given to the fact that layers of combustible or non-combustible materials may cause increased ignition risks. See Annex C.

The critical air gap can be lost for many reasons and it is in most designs difficult to measure or monitor. As fans generally are not supervised continuously, contact between rotating and stationary parts may prevail for relatively long time intervals. Therefore even a seldom or short term exposure to an explosive atmosphere will represent a high risk. Material pairings shall be chosen to minimise this hazard.