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Načrtovanje ventilatorjev za delovanje v potencialno eksplozivnih atmosferah

Design of fans working in potentially explosive atmospheres

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Design of fans working in potentially explosive atmospheres

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Konstruktion von Ventilatoren für den Einsatz in explosionsgefährdeten Bereichen

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Foreword

This document (prEN 14986:2004) 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 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 94/9/EC of 23 March 1994.

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

Annexes A, B, C, D and F are normative.

Annex E is informative.

Introduction

This document is a type C standard as stated in EN 1070.

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

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

This standard specifies the constructional requirements for ventilating fans constructed to Group II G categories 1, 2 and 3 , and Group II D categories 2 and 3, intended for use in explosive atmospheres.

Operation conditions for the different categories of fans used in this standard are defined in clause 4.

It does not apply to fans intended for use with Group II C gases, as listed in the annex to EN 50014

This 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.

The 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, outside, or inside and outside of the fan.

This standard is valid for fans working in ambient atmospheres having absolute pressures ranging from 0,8 bar to 1,1 bar, temperatures ranging from – 20 °C to + 60 °C, maximum 21 vol. % oxygen content and an aerodynamic energy increase of less than 25 kJ/kg.

NOTE 2 This 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. 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.

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.

EN 294, *Safety of machinery; safety distances to prevent danger zones being reached by the upper limbs.*

EN 414:2000, *Safety of machinery – Rules for the drafting and presentation of safety standards.*

EN 1050, *Safety of machinery – Principles for risk assessment.*

EN 1070, *Safety of machinery – Terminology.*

EN 1127-1:1997, *Explosive atmospheres – Explosion prevention and protection – Part 1: Basic concepts and methodology.*

EN 12874:2001, *Flame arresters – Performance requirements, test methods and limits for use.*

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

EN 13463-5:2003, *Non-electrical equipment intended for use in potentially explosive atmospheres – Part 5: Protection by constructional safety "c".*

prEN 13463-6, *Non-electrical equipment intended for use in potentially explosive atmospheres – Part 6: Protection by control of ignition sources "b".* [1)]

prEN 14460, *Explosion resistant products.*[2)]

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1) To be published

EN 50014, *Electrical apparatus for potentially explosive atmospheres – General requirements.*

EN 50018, *Electrical apparatus for potentially explosive atmospheres – Flameproof enclosures "d".*

EN 50281-1-2, *Electrical apparatus for use in the presence of combustible dust – Part 1-2: Electrical apparatus protected by enclosures; Selection, installation and maintenance.*

EN 60079-14, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines).*

EN 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection "n" (IEC 60079-15:2001, modified).*

EN 60529, *Degrees of protection provided by enclosures (IP Code).*

EN ISO 12100-1, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology.*

EN ISO 12100-2, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles.*

ISO 281, *Rolling bearings; dynamic load ratings and rating life.*

ISO/DIS 1210, *Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame (50 W) ignition source (Revision of ISO 1210:1992).*

ISO 12499, *Industrial fans – Mechanical safety of fans – Guarding.*

ISO 13349:1999, *Industrial 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 European Standard, the terms and definitions given in EN 1070, EN 1127-1, EN 12874 and EN 13463-1, and the following apply.

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

3.2
integrated flame arrester
flame arrester with flame arrester housing and flame arrester elements being part of the fan

3.3
plastic
polymer material with well defined and assured non-ignition properties

3.4
contact diameter
diameter of a rotating part at the point where it can contact a stationary part

2) To be published

4 Requirements for all fans

4.1 General

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

NOTE This 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, etc.).

4.2 Ignition hazard assessment

4.2.1 General

An ignition hazard assessment according to EN 13463-1 shall be carried out to identify additional hazards which are not covered by the standard and to determine the potential ignition sources and the level of ignition protection necessary to meet the intended category.

NOTE Annex F provides a list of hazards which can occur in many fans.

For the purposes of fans made according to this 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 12100-1.)

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. This can happen for a variety of reasons, including

— variation of a property or of a dimension of the processed material or of the workpiece (e. g. warping of the casing);

— disturbance of the power supply or other services;

— unnoticed long time operation with defect bearing and resulting contact between impeller and housing;

— release of the impeller by vibrations where the impeller is only pressed on the shaft.

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 to categories

Fans which are used to convey an explosive gas, vapour, mist or dust atmosphere are assigned to categories 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.

NOTE The category need not necessarily be the same inside and outside the fan.

4.4 Temperatures

4.4.1 General

Both the temperature of potentially hot surfaces and the temperature of the conveyed gas and/or of the gas surrounding the fan shall be considered. Independent of fan category, the temperature limits specified in EN 13463-1 shall not be exceeded. Special attention is to be paid to the fan-specific increase of temperatures during normal and abnormal service conditions due to gas compression, friction and heat generating components like electric motors.

4.4.2 Surface temperatures

According to EN 13463-1 fans are characterised by the maximum surface temperature inside/outside the fan given in table 1. The fan manufacturer has to indicate clearly in his user instructions, that the user shall, according to the nature of the gas, mist or dust in his system, choose the appropriate temperature class for the fan, so the maximum surface temperature in table 1 is never exceeded.

Table 1 — Classification of maximum surface temperature

Temperature class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

If the atmosphere inside and/or outside the fan contains dust, then the requirements of EN 13463-1 shall be fulfilled.

4.4.3 Gas temperatures

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 or 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 the maximum motor temperature. This speed shall be indicated on the nameplate.

High temperature increases during normal service as in some high pressure fans may require inlet temperature to be less than the + 60 °C given in the scope of this standard.

The manufacturer's instructions shall include the minimum and maximum air flow rates which are required to maintain the T-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.

NOTE 1 Tests have shown that at gas temperatures above + 60 °C ignition hazards increase considerably.

NOTE 2 Electric motors and other temperature sensitive components shall receive special attention as they generally are designed for a maximum ambient temperature of + 40 °C.

4.4.4 Maximum surface temperature

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. The maximum surface temperature inside the fan shall be the greater of either the surface temperature or 120 % of the maximum outlet gas temperature determined for an inlet gas temperature of 60 °C.

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

4.5 Mechanical design criteria

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 a single 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.

All impellers, shafts, bearings, pulleys, cooling disks etc. shall be maintained in position, or protected against displacement (see section under appropriate category for details).

This requirement shall not apply to the bearings incorporated within electric motors which shall be subject to the requirements specified in EN 50014. Motor end float shall be limited e.g. by the use of wave washers.

4.6 Casings

The fan casing shall be of a substantially rigid design. For a fan having a driving motor of more than 11 kW a continuously welded casing is required. Cover plates and inspection doors may be held in position by bolts if the construction is substantially leak proof in fans for installation mode D. Split casings or casings with removable segments shall be manufactured as substantially gas-tight with machined contact areas and/or appropriate gaskets if required. The test to confirm gas-tightness shall be made with blanked-off inlet and outlet and with blanked-off shaft entry hole when appropriate.

A substantially leak-proof casing is defined as having a leakage rate not exceeding that specified for leakage category D in ISO 13349:1999, table 4. The gas tightness of the seal is not addressed.

Furthermore the casing shall only produce small deformations relative to the clearance within the design temperature range (see 4.15).

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 seconds without causing an ignition risk.

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

Furthermore impellers shall only produce small deformations relative to the clearance within the design temperature range (see 4.15).

4.8 Materials for rotating and stationary parts of fans

4.8.1 General

In view of possible friction, which can be expected during normal operation or due to rare or even very 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 E.

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.

All alloys except aluminium alloys (sheet or cast) shall contain not more than 15 % aluminium and shall have a homogenous structure. Paints and coatings shall contain not more than 10 % aluminium per unit mass.

4.8.2 Acceptable material pairings

One of the material pairings given in table 2 for the different categories shall be used in the construction of ignition protected fans.

The pairings shown are for the stationary rubbing part and the rotating rubbing part. Either material (1) or material (2) may be chosen for the rotation part subject to satisfactory mechanical stress performance over the design life of the fan.

For category 1 fans this standard requires additional protective measures, thus rotating and stationary parts of fans acceptable for category 2 fans are also suitable for category 1.