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Industrial fans — Vocabulary and definitions of categories

Ventilateurs industriels — Vocabulaire et définitions des catégories

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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.

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.

International Standard ISO 13349 was prepared by Technical Committee ISO/TC 117, *Industrial fans.*

Annex A of this International Standard is for information only.

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Introduction

This International Standard reflects the importance of a standardized approach to the terminology of fans.

The need for an International Standard has been evident for some considerable time. To take just one example, the coding of driving arrangements differs from manufacturer to manufacturer. What one currently calls Arrangement 1 may be known by another as Arrangement 3. The confusion for the customer is only too apparent. For similar reasons, it is essential to use standardized nomenclature to identify particular parts of a fan.

Wherever possible, in the interests of international comprehension, this International Standard is in agreement with similar documents produced by Eurovent, AMCA, VDMA (Germany), AFNOR (France) and UNI (Italy). They have, however, been built on where the need for amplification was apparent.

Use of this International Standard will lead to greater understanding among all parts of the air-moving industry. It is hoped that manufacturers, consultants, contractors and users will adopt and refer to this International Standard as soon as possible.

Industrial fans — Vocabulary and definitions of categories

1 Scope

This International Standard provides a vocabulary and defines categories for general purpose industrial fans and their component parts. It is applicable to any fan used for industrial purposes, including the ventilation of buildings and mines, but excluding ceiling, pedestal and similar circulation types of fans such as those commonly used for non-industrial purposes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5801:1997, *Industrial fans — Performance testing using standardized airways.*

ISO 5802:—[1], *Industrial fans — Performance testing in situ.*

ISO 13350:1999, *Industrial fans — Performance testing of jet fans.*

ISO 13351:1996, *Industrial fans — Dimensions.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
fan
rotary-bladed machine which receives mechanical energy and utilizes it by means of one or more impellers fitted with blades to maintain a continuous flow of air or other gas passing through it and whose work per unit mass does not normally exceed 25 kJ/kg

NOTE 1 The term "fan" is taken to mean the fan as supplied without any addition to the inlet or outlet, except where such addition is specified.

NOTE 2 Fans are defined according to their installation category, function, fluid path and operating conditions.

NOTE 3 If the work per unit mass exceeds a value of 25 kJ/kg, the machine is termed a turbocompressor. This means that, for a mean stagnation density through the fan of 1,2 kg/m^3, the fan pressure will not exceed 1,2 $\times$ 25 kJ/kg, i.e. 30 kPa, and the pressure ratio will not exceed 1,30 since atmospheric pressure is approximately 100 kPa.

[1] To be published.

3.2
air
in this International Standard, an abbreviation for the expression "air or other gas"

3.3
standard air
by convention, air with a density of 1,2 kg/m^3

3.4 Fan installation types according to the arrangement of ducting (see figure 1)

3.4.1
installation type A
installation with free inlet and free outlet

[ISO 5801 and ISO 5802]

3.4.2
installation type B
installation with free inlet and ducted outlet

[ISO 5801 and ISO 5802]

3.4.3
installation type C
installation with ducted inlet and free outlet

[ISO 5801 and ISO 5802]

3.4.4
installation type D
installation with ducted inlet and ducted outlet

[ISO 5801 and ISO 5802]

3.5 Types of fan according to their function

3.5.1
ducted fan
fan used for moving air within a duct

NOTE Such a fan may be arranged in an installation of type (B), (C) or (D) (see figures 2, 3 and 5).

3.5.2
partition fan
fan used for moving air from one free space to another separated from the first by a partition having an aperture in which or on which the fan is installed

NOTE Such a fan should be arranged in an installation of type (A) (see figure 6).

3.5.3
jet fan
fan used for producing a jet of air in a space and unconnected to any ducting (see figures 7 and 8)

NOTE The air jet may be used for example for adding momentum to the air within a duct, a tunnel or other space, or for intensifying the heat transfer in a determined zone.

3.6 Fan types according to the fluid path within the impeller

3.6.1
centrifugal fan
fan in which the air enters the impeller with an essentially axial direction and leaves it in a direction perpendicular to this axis (see figure 2)

NOTE 1 The centrifugal fan is also known as a radial-flow fan.

NOTE 2 The impeller may have one or two inlet(s) and may or may not include a shroud and/or a backplate (centreplate) (see figure 14).

NOTE 3 The impeller is defined as "backward-curved or inclined", "radial" or "forward-curved" depending on whether the outward direction of the blade at the periphery is backward, radial or forward relative to the direction of the rotation (see figure 14).

NOTE 4 A centrifugal fan may be of the low, medium or high pressure type, according to the aspect ratio of fan inlet diameter to outside diameter of the impeller. These terms indicate that the pressure generated at a given flowrate is low, medium or high.

NOTE 5 Figure 5 shows a cross-section through a family of impellers having the same inlet diameter. Fans with ratios of fan inlet/outside impeller diameter of greater than approximately 0,63 are considered "low aspect ratio", and lower than approximately 0,4 are considered "high aspect ratio". Medium aspect ratio centrifugal fans are intermediate between these two figures.

NOTE 6 The impeller diameter and the casing scroll radii increase with the pressure range for which the fan is designed.

NOTE 7 These categories will also be affected by the ability to run at the necessary peripheral speed (see 5.2 and table 1).

3.6.2
axial-flow fan
fan in which the air enters and leaves the impeller along essentially cylindrical surfaces coaxial with the fan (see figure 3)

NOTE 1 An axial-flow fan may be of the low, medium or high pressure type according to the aspect ratio of hub diameter to outside impeller diameter. These terms indicate that the pressure generated at a given flowrate is low, medium or high.

NOTE 2 Figure 10 shows a cross-section through a family of impellers having the same outside diameter. Fans with ratios of hub/outside impeller diameter of less than approximately 0,4 are considered "low aspect ratio", and greater than approximately 0,71 are considered "high aspect ratio". Medium aspect ratio axial fans are intermediate between these two figures.

NOTE 3 These categories will also be affected by the ability to run at the necessary peripheral speed.

3.6.2.1
contra-rotating fan
axial-flow fan which has two impellers arranged in series and rotating in opposite directions

3.6.2.2
reversible axial-flow fan
axial-flow fan which is specially designed to rotate in either direction regardless of whether the performance is identical in both directions

3.6.2.3
propeller fan
axial-flow fan having an impeller with a small number of broad blades of uniform material thickness and designed to operate in an orifice

3.6.2.4
plate mounted axial-flow fan
axial-flow fan in which the impeller rotates in an orifice or spigot of relatively short axial length, the impeller blades being of aerofoil section

3.6.2.5
vane axial fan
axial-flow fan suitable for ducted applications which has guide vanes before or after the impeller, or both

3.6.2.6
tube axial fan
axial-flow fan without guide vanes, suitable for ducted applications

3.6.3
mixed-flow fan
fan in which the fluid path through the impeller is intermediate between the centrifugal and axial-flow types (see figures 7 and 11)

3.6.4
cross-flow fan
fan in which the fluid path through the impeller is in a direction essentially at right angles to its axis both entering and leaving the impeller at its periphery (see figure 12)

3.6.5
ring-shaped fan
air moving device for which the circulation of fluid in the toric casing is helicoidal

NOTE The rotation of the impeller, which contains a number of blades, creates a helicoidal trajectory which is intercepted by one or more blades depending on the flowrate. The impeller transfers energy to the fluid (see figure 13).

3.6.6
multi-stage fan
fan having two or more impellers working in series (2-stage fan, 3-stage fan, etc.)

NOTE 1 Multi-stage fans may have guide vanes and/or interconnecting ducts between successive impellers.

NOTE 2 The blades of an impeller may be either of a profiled section (as an aerofoil) or of uniform thickness (see figure 14).

3.6.7
tubular centrifugal fan
fan having a centrifugal impeller used in an inline ducted configuration (see figure 4)

3.6.8
bifurcated fan
fan having an axial, mixed-flow or centrifugal impeller in an inline configuration where the direct-drive motor is separated from the flowing air stream by means of a compartment or tunnel (see figure 25 Bd)

3.7 Types of fan according to operating conditions

3.7.1
general purpose fan
fan suitable for handling air which is nontoxic, not saturated, noncorrosive, nonflammable, free from abrasive particles and within a temperature range from − 20 °C to + 80 °C (maximum temperature 40 °C if the motor and/or the fan bearings are in the air stream)

3.7.2
special purpose fan
fan used for special operating conditions (see 3.7.2.1 to 3.7.2.11)

NOTE 1 A fan may have a combination of special features.

NOTE 2 The operating conditions stated below represent a typical range, but the list is not necessarily complete. Other types having special features to suit specific applications should be agreed between the manufacturer and purchaser.

3.7.2.1
hot gas fan
fan used for handling hot gases continuously

NOTE 1 Special materials shall be incorporated as necessary for the fan which may have a direct or indirect drive.

NOTE 2 The motor on a direct-drive fan may be either in the air stream or separated from it.

NOTE 3 Indirect-drive fans should incorporate a means for cooling belts, bearings or other drive components where necessary (see 5.3.2 for designation).

3.7.2.2
smoke-ventilating fan
fan suitable for handling hot smoke for a specified time/temperature profile

NOTE 1 Special materials are incorporated as necessary for the fan, which may have a direct or indirect drive.

NOTE 2 The motor may be either in the air stream on a direct-drive fan, or separated from it.

NOTE 3 Indirect-drive fans incorporate a means for cooling belts, bearings or other drive components where necessary (see 5.3.3 for categorization).

3.7.2.3
wet-gas fan
fan suitable for handling air containing particles of water or any other liquid

3.7.2.4
gas-tight fan
fan with a suitable sealed casing to match a specified leakage rate at a specified pressure

NOTE Depending upon the leakage specification, this can involve special attention being paid to all services which penetrate the casing, such as inspection means, lubricator fittings and electrical supply, as well as the details of the connecting flanges (see 5.3.4 for categorization).

3.7.2.5
dust fan
fan suitable for handling dust-laden air, designed to suit the dust being handled

3.7.2.6
conveying fan
transport fan
fan suitable for the conveying of solids (e.g. wood chips, textile waste, pulverized materials) and dust entrained in the air stream, designed to suit the material being conveyed

NOTE A conveying/transport fan may be of direct or indirect type, depending on whether or not the handled material passes through the impeller.

3.7.2.7
nonclogging fan
fan having an impeller designed to minimize clogging by virtue of its detailed shape, or by the use of special materials

NOTE The fan may also incorporate other features to allow the use of cleaning sprays and to facilitate the removal of any material.

3.7.2.8
abrasion-resistant fan
fan designed to minimize abrasion, having parts that are especially subject to wear constructed in suitable abrasion-resistant materials and/or easily replaceable

3.7.2.9
corrosion-resistant fan
fan constructed in suitable corrosion-resistant materials or suitably treated to minimize corrosion by specified agents

3.7.2.10
spark-resistant fan
ignition-protected fan
fan with features designed to minimize the risk of sparks or hot spots resulting from contact between moving and stationary parts that may cause the ignition of dust or gases

NOTE No bearings, drive components or electrical devices should be placed in the air or gas stream, unless they are constructed in such a manner that failure of that component cannot ignite the surrounding gas stream (see 5.3.4 for categorization).

3.7.2.11
powered roof ventilator
fan designed for mounting on a roof and having exterior weather protection

3.8 Fan elements

3.8.1
fan inlet
opening, usually circular or rectangular, through which the air first enters the fan casing

NOTE 1 If the fan is provided with an inlet-connecting flange or spigot, the fan inlet dimensions are measured inside this connection. The inlet area is the gross area measured inside this flange, i.e. no deductions are made for blockages such as motors, bearing supports, etc.

NOTE 2 When the inlet area is not clearly defined, it should be agreed between the parties to the contract.

3.8.2
fan outlet
opening, usually circular or rectangular, through which the air finally leaves the fan casing

NOTE 1 If the fan is provided with an outlet connecting flange or spigot, the fan outlet dimensions are measured inside this connection. When the fan is delivered with a diffuser and the performance is quoted with this fitted, the area of the fan outlet is to be taken as equal to the outlet area of the diffuser.

NOTE 2 When the outlet area is not clearly defined, it should be agreed between the parties to the contract.

NOTE 3 For the special requirements of jet fans, see ISO 13350.

3.8.3
impeller tip diameter
maximum diameter measured over the tips of the blades of the impeller (see ISO 13351)

3.8.4
size designation
nominal impeller tip diameter, defined as the impeller tip diameter on which the design of that fan is based

4 Units and symbols

The following primary units and symbols for the parameters listed shall be used.

Parameter	Symbol	Unit
Volume flowrate	q_V	m^3/s
Fan pressure	p_F	Pa
Power	P	W
Torque		Nm
Gas density	ρ	kg/m^3
Impeller tip speed	u	m/s
Outlet or duct velocity	v	m/s
Rotational frequency	n	r/s
Rotational speed	N	r/min
Dimensions		mm
Moment of inertia		kg·m^2
Stress		Pa
Energy		kJ
Temperature	θ	K
Work per unit mass	y	kJ/kg
Thrust		kN

4.1 Multiples of primary units

The choice of the appropriate multiple or submultiple of an SI unit is governed by convenience. The multiple chosen for a particular application shall be that which will lead to numerical values within a practical range (e.g. kilopascal for pressure, kilowatts for power and megapascal for stress).

4.2 Units of time

The second is the SI base unit of time, although outside SI the minute has been recognized by CIPM as necessary to retain for use because of its practical importance. Manufacturers may, therefore, continue with the use of r/min for rotational speed.

4.3 Temperature of air/gas

The kelvin is the SI base unit of thermodynamic temperature and is preferred for most scientific and technological purposes. The degree Celsius (°C) is acceptable for practical applications.

5 Fan categories

5.1 General

Fans may be categorized according to:

a) suitability for the fan pressure;

b) suitability of construction (including features required for smoke ventilation, gas tightness and ignition protection);

c) driving arrangement;

d) inlet and outlet conditions;

e) method of fan control;

f) rotation and position of parts;

g) characteristic dimensions.

Examples of the use of the definitions and categories to identify a fan in a specification are given in annex A.

5.2 Suitability for the fan pressure

A fan may also be defined as being low, medium or high pressure, according to the level of work per unit mass, and whether the influence of compressibility of the air or gas being handled has to be taken into account. For a detailed account of these considerations, refer to ISO 5801.

A low-pressure fan is then defined as having a pressure ratio less than 1,02 and a reference Mach No. of less than 0,15. This corresponds to a pressure rise of less than 2 kPa when handling standard air.

A medium-pressure fan is defined as having a pressure ratio greater than 1,02 and less than 1,1. The reference Mach No. shall be less than 0,15. This corresponds to a pressure rise of 2 kPa to 10 kPa.

A high-pressure fan is defined as having a pressure ratio and pressure rise greater than the above.

5.2.1 Work per unit mass

A convention is used for all industrial fans except jet fans (see ISO 13350), denoting the work per unit mass as the quotient of air power and mass flowrate. The fan pressure is approximately equal to the product of work per unit mass and the mean stagnation density of the fluid within the fan.

5.2.2 Fan categories

Depending on its peripheral speed, a fan impeller will develop more or less pressure. This International Standard defines a range of "fan categories" where the fan pressure at maximum efficiency and maximum rotational speed is not less than the value given in table 1. In any event, this defined fan pressure shall not exceed 95 % of the maximum pressure developed by the fan at its maximum speed.

5.2.3 Changes in air density

These categories shall also be used to indicate whether or not the change in air density within the fan shall be considered. For a low-pressure fan this change may be neglected. For a high-pressure fan, this change shall not be neglected, whereas for a medium-pressure fan, it may or may not be neglected depending on the desired accuracy. Detailed mechanical design and construction of the rotational elements will be determined by the peripheral speed and, therefore, the pressure for which the fan is specified.

Table 1 — Categorization of fan according to level of work per unit mass

Fan description	Code	Work per unit mass kJ/kg	“Maximum” fan pressure (for standard air) kPa	Category
Low pressure	L	> 0 and ≤ 0,6	> 0 and ≤ 0,7	0
		> 0,6 and ≤ 0,83	> 0,7 and ≤ 1	1
		> 0,83 and ≤ 1,33	> 1 and ≤ 1,6	2
		> 1,33 and ≤ 1,67	> 1,6 and ≤ 2,0	3
Medium pressure	M	> 1,67 and ≤ 3	> 2,0 and ≤ 3,6	4
		> 3 and ≤ 5,25	> 3,6 and ≤ 6,3	5
		> 5,25 and ≤ 8,33	> 6,3 and ≤ 10	6
High pressure	H	> 8,33 and ≤ 13,33	> 10 and ≤ 16	7
		> 13,33 and ≤ 18,67	> 16,0 and ≤ 22,4	8
		> 18,67 and ≤ 25	>22,4 and ≤ 30	9
Turbocompressors		> 25	> 30	

5.3 Suitability of construction

5.3.1 Categorization according to casing construction

Fans are used for a variety of purposes (see 3.7). The air or gas handled may be clean or contain moisture or solid particles and may be at ambient or other temperature. Connection to its associated ducting can be via flexible elements or alternatively it may be attached directly, such that the casing has to withstand additional loads due to the dead weight of these connections. Where a high or low temperature is present, further loading can result from the effects of expansion or contraction. Casing thickness and/or stiffening are also determined by the ability to withstand the specified fan pressure and dynamic loads and by the need for a margin to counter the effects of any erosion or corrosion. For all these and other reasons, different methods of casing construction and different casing thicknesses are appropriate to the application.

The categorization in table 2 reflects current practice and shall be used only to assist specification. It in no way indicates any form of grading. Category 1 is as valid for clean air ventilation as Category 3 is preferred for heavy industrial requirements.

Table 2 — Categorization according to method of casing construction

Category	Typical casing features	Usage	Casing thickness
1	Lockformed, spot welded or screwed construction. Cradle or angle frame mounting	— Light HVAC Clean air	< 0,0025 D
2	Lockformed, seam welded or continuously welded construction. Semi-universal design with bolted on side-plates	— Heavy HVAC — Light industrial Light dust or moisture	> 0,0025 D
3	Fully welded fixed discharge	— Heavy industrial • Dirty air containing moisture and/or solids, or • High pressure, or • High power	> 0,00333 D

NOTE D is the nominal impeller diameter, in millimetres.

5.3.2 Designation for hot-gas fan

Where a fan is suitable for continuous operation up to a stated maximum temperature (hot gas fan, see 3.7.2.1), this should be indicated on the conventional fan rating plate itself.

The following designation shall be used:

T, followed by the maximum temperature, in degrees Celsius, for continuous operation.

EXAMPLE T/500 denotes a fan rated for a maximum continuous temperature of 500 °C.

5.3.3 Designation and recommended categorization for smoke-ventilating fans (see 3.7.2.2)

If the fan is also, or only, capable of short-term operation at a high temperature, this information shall be clearly stated on a separate label.

The following designation shall be used:

HT, followed by temperature in degrees Celsius and time, at the stated temperature, in hours or decimals of an hour.

EXAMPLE HT/300/0,5, denotes "a high-temperature fan rated for operation at 300 °C for 0,5 h (i.e. 30 min)".

The recommended categories for smoke-ventilating fan are given in table 3.