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Fans — Efficiency classification for fans —

Part 6:

Calculation of the fan energy index

Ventilateurs — Classification du rendement des ventilateurs —

Partie 6: Calcul de l'indice énergétique des ventilateurs

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 117, *Fans*.

A list of all parts in the ISO 12759 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The fan industry is of a global nature, with a considerable degree of exporting and licensing. To ensure that the defining fan performance characteristics are common throughout the world, a series of standards have been developed. It is the belief of the industry that there is now a need for minimum efficiency standards to be recognized.

To encourage their implementation, a classification system is proposed which incorporates a series of efficiency bands. With improvements in technology and manufacturing processes, the minimum efficiency levels can be reviewed and increased in time.

This document differs from others in this series in that the fan is not evaluated at its peak efficiency value. Rather, the fan is evaluated at every duty point within its stated performance range. In doing so, this document addresses both the design and selection of fans for reduced power consumption.

The fan energy index provides a consistent basis to compare fan energy performance across fan types and sizes at a given fan duty point. This document can be used by fan specifiers to communicate fan efficiency design intent and by those selecting fans to compare the energy use of various fan options. With improvements in technology and manufacturing processes, the minimum allowable fan energy index can be reviewed and increased in time.

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Fans — Efficiency classification for fans

Part 6: Calculation of the fan energy index

1 Scope

This document defines the calculation method for determining the fan energy index (FEI), which is an energy efficiency metric for fan duty points. This metric provides a standardized and consistent basis to compare fan energy performance across fan types and sizes at a given fan duty point.

This document is applicable to fans driven by electric motors and fans without drives. It is not applicable to circulating fans or air curtains.

The fan energy index can only be calculated for fan duty points above a minimum air power of 125 W (where air power is the product of volume flow rate and fan static pressure) or above a minimum volume flow rate of 2,0 m³/s.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5801:2017, *Fans — Performance testing using standardized airways*

[ISO 12759-1, Fans — Efficiency classification for fans — General information for fans](#)

[ISO 12759-2:2019, Fans — Efficiency classification for fans — Part 2: Standard losses for drive components](#)

ISO 13348, *Industrial fans — Tolerances, methods of conversion and technical data presentation*

[ISO 13349-1:2022, Fans — Vocabulary and definitions of categories — Part 1: Vocabulary](#)

ISO 13350, *Fans — Performance testing of jet fans*

[ISO 12759-1, Fans — Efficiency classification for fans — General information for fans](#)

[ISO 12759-2:2019, Fans — Efficiency classification for fans — Part 2: Standard losses for drive components](#)

IEC 60034-30-1:2014, *Rotating electrical machines—Part 30-1: Efficiency classes of line operated AC motors (IE code)*

IEC 60034-2-1, *Rotating electrical machines—Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC 60034-2-3, *Rotating electrical machines—Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors*

ANSI/AMCA Standard 230, *Laboratory Methods of Testing Air Circulating Fans for Rating and Certification*

ANSI/AMCA Standard 260, *Laboratory Methods of Testing Induced Flow Fans for Rating*

3 Terms, definitions and symbols

~~3.1.1~~ Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13349-1 and ISO 12759-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ~~ISO~~ Online browsing platform: available at <https://www.iso.org/obp>~~https://www.iso.org/obp~~
- ~~IEC~~ Electropedia: available at <https://www.electropedia.org/>~~https://www.electropedia.org/~~

3.1 Terms and definitions

3.1.1 General terms

3.1.1.1

fan

rotary-bladed machine that receives mechanical energy and utilizes it by means of one or more *impellers* ~~(3.1.1.2)~~(3.1.1.2) 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-to-entry: See ISO 13349-1:2022, 3.1.1 for a more complete definition.

3.1.1.2

impeller

rotating part of the *fan* ~~(3.1.1.1)~~(3.1.1.1) that imparts energy to the air stream

[SOURCE: ISO 13349-1:2022, 3.7.3, modified – changing gas flow to air stream]

3.1.1.3

housing

stationary part of the *fan* ~~(3.1.1.1)~~(3.1.1.1) that interacts with the air stream passing through the *impeller* ~~(3.1.1.2)~~(3.1.1.2)

Note_1-to-entry: A housing can be an element around the *impeller* ~~(3.1.1.2)~~(3.1.1.2) which guides the air stream towards, through and from the impeller.

Note_2-to-entry: A housing can have additional parts included within or attached to it that affect the performance of the *fan* ~~(3.1.1.1)~~(3.1.1.1), such as an inlet bell (also known as venturi), inlet cone, inlet radius, inlet ring, inlet guide vane, outlet guide vane or outlet diffuser.

3.1.1.4

fan without drives

non-driven fan

bare shaft fan

fan ~~(3.1.1.1)~~(3.1.1.1) without motor, *transmission* ~~(3.1.1.8)~~(3.1.1.8), or *motor controller* ~~(3.1.1.14)~~(3.1.1.14)

Note_1-to-entry: In this definition, the term drive refers to motors, transmissions, and motor controllers.

**3.1.1.5
driven fan**

fan (3.1.1.1)(3.1.1.1) driven by an electrical motor, with or without a transmission (3.1.1.8)(3.1.1.8) or motor controller (3.1.1.14)(3.1.1.14)

Note 1 to entry: In this document, the term motor always refers to an electric motor.

[SOURCE: ISO 13349-1:2022, 3.1.3, modified – Note 1 included in the body of the term]

Note 1 to entry: In this document, the term motor always refers to an electric motor.

**3.1.1.6
direct driven fan**

driven fan (3.1.1.5)(3.1.1.5) configuration in which the impeller (3.1.1.2)(3.1.1.2) is connected directly to the motor

**3.1.1.7
belt driven fan**

driven fan (3.1.1.5)(3.1.1.5) configuration in which the impeller (3.1.1.2)(3.1.1.2) is connected to the motor through a set of belts and pulleys mounted on the motor shaft and fan shaft

Note 1 to entry: This includes fans with V-belt transmissions (3.1.1.10)(3.1.1.10) or synchronous belt transmissions (3.1.1.11)(3.1.1.11).

**3.1.1.8
transmission**

component that transfers energy from a motor to an impeller

EXAMPLE Pulleys, belts, gears, couplings

**3.1.1.9
V-belt transmission**

form of transmission (3.1.1.8)(3.1.1.8) utilizing drive belts having a substantially trapezoidal cross-section that use pulleys having smooth contact surfaces

Note 1 to entry: Conventional V-belts have a constant cross-section along their length, while notched V-belts (also known as cogged V-belts) have slots running perpendicular to their length. The slots reduce bending resistance and offer improved efficiency over conventional V-belts.

**3.1.1.10
synchronous belt transmission**

form of transmission (3.1.1.8)(3.1.1.8) utilizing drive belts having a substantially rectangular cross-section containing teeth that engage corresponding teeth on the pulleys, resulting in no-slip power transmission

Note 1 to entry: These belts are sometimes called timing or toothed belts.

**3.1.1.11
standalone fan**

fan (3.1.1.1)(3.1.1.1) in at least a minimum testable configuration

[SOURCE: ISO 13349-1:2022, 3.1.4, modified – addition of an example and of more detail to the notes]

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Note_1_to_entry:- This includes any motor, transmission or motor controller if included in the rated fan. It also includes any appurtenances included in the rated fan, and it excludes the impact of any surrounding equipment whose purpose exceeds or is different than that of the fan. See 4.1. See 4.1.

Note_2_to_entry:- Standalone fans do not include provisions for air conditioning, air filtration, air mixing, air treatment or heating.

EXAMPLE EXAMPLE Power roof ventilators, side-wall exhaust fans, inline fans, jet fans and induced-flow laboratory exhaust fans.

[SOURCE: ISO 13349-1:2022, 3.1.4, modified – addition of an example and of more detail to the notes]

3.1.1.12
embedded fan
integrated fan

fan (3.1.1.1) fan (3.1.1.1) that is set or fixed firmly inside or attached to a surrounding piece of equipment whose purpose exceeds that of a fan (3.1.1.1) (3.1.1.1) or is different than that of a standalone fan (3.1.1.1) (3.1.1.1)

EXAMPLES Note 1 to entry: The surrounding equipment can have safety or energy efficiency requirements of its own.

Note 2 to entry: Embedded fans are also known as integrated fans.

EXAMPLE Supply fans in air handling units, condenser fans in heat rejection equipment, tangential blowers in air curtain units and induced or forced draft combustion blowers in boilers or furnaces.

Note 1 to entry: The surrounding equipment can have safety or energy efficiency requirements of its own.

Note 2 to entry: Embedded fans are also known as integrated fans.

3.1.1.13
motor controller

device that is used to control the speed of the motor and subsequently the fan (3.1.1.1) (3.1.1.1)

3.1.1.14
regulated motor

motor whose efficiency or power usage is subject to regional or national regulation

EXAMPLES Europe: Commission Regulation (EU) 2019/1781
- China: GB 18613
- United States: Code of Federal Regulations 10CFR Part 431

3.1.1.15
default motor efficiency

default efficiency assigned to the motor at a given motor output power when either the specific motor is not identified or the efficiency of the motor used is unknown

Note_1_to_entry:- The use of a default efficiency is designed to represent typically available motors. Since motor efficiency regulations are controlled regionally, the default motor efficiency shall reflect these regulations. See 5.3.5 See 5.3.5 for examples.

3.1.1.16 duty point

single volume flow rate (q_v) and pressure (p_f or p_{fs}) point within the published operating range of the fan (3.1.1.1)(3.1.1.1)

3.1.1.17 reference electrical power

reference power used to relate the performance of all fans to a common baseline

Note_1-to-entry:-The reference electrical power defines a single value of fan electrical input power for a given volume flow rate and fan pressure.

3.1.2 Impeller types

NOTE See ISO 13349-1:2022 for a more complete description of the variations between impeller types. The definitions below include only the differentiation needed for this standard.

3.1.2.1 axial impeller propeller

impeller (3.1.1.2)(3.1.1.2) with a number of blades extending radially from a central hub in which airflow through the impeller is axial in direction; that is, airflow enters and exits the impeller parallel to the shaft axis (i.e. with a fan flow angle (3.1.2.5)(3.1.2.5) $\leq 20^\circ$)

Note_1-to-entry:-Blades can either be single thickness or airfoil shaped.

3.1.2.2 centrifugal impeller

impeller (3.1.1.2)(3.1.1.2) with a number of blades extending between a back plate and shroud in which airflow enters axially through one or two inlets and exits radially at the impeller periphery, either into open space or into a housing, with a fan flow angle (3.1.2.5)(3.1.2.5) $\geq 70^\circ$

Note_1-to-entry:-Impellers (3.1.1.2)(3.1.1.2) can be classified as single inlet or double inlet.

Note_2-to-entry:-Blades can be tilted backward or forward with respect to the direction of impeller rotation. Impellers with backward tilted blades can be airfoil shaped (AF), backward curved single thickness (BC), backward inclined single thickness flat (BI) or radial tipped (RT). Impellers with forward tilted blades are known as forward curved (FC).

3.1.2.3 radial impeller

form of centrifugal impeller (3.1.2.2)(3.1.2.2) with a number of blades extending radially from a central hub in which airflow enters axially through a single inlet and exits radially at the impeller periphery into a housing with impeller blades positioned such that the outward direction of the blade at the impeller periphery is perpendicular within 25° to the axis of rotation

Note_1-to-entry:-Radial impellers can optionally have a back plate and/or shroud.

3.1.2.4 mixed flow impeller

impeller (3.1.1.2)(3.1.1.2) with construction characteristics between those of an axial impeller (3.1.2.1)(3.1.2.1) and centrifugal impeller (3.1.2.2)(3.1.2.2) with a fan flow angle (3.1.2.5)(3.1.2.5) between 20° and 70°

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Note_1_to_entry: Airflow enters axially through a single inlet and exits with combined axial and radial directions at a mean diameter greater than the inlet.

Note_2_to_entry: Mixed flow impellers are sometimes known as diagonal impellers.

Note_3_to_entry: Mixed flow impellers are abbreviated as MF in [Table A.1-Table A.1](#).

3.1.2.5 fan flow angle

angle of the centreline of the air-conducting surface of a fan blade measured at the midpoint of its trailing edge with the centreline of the rotation axis, in a plane through the rotation axis and the midpoint of the trailing edge

3.1.3 Fan types

NOTE See ISO 13349-1:2022 for a more complete description of the variations between fan types. The definitions below include only those fan types that are tested differently, function differently, or have a unique advantage, other than efficiency, over other fan types (e.g., sound levels, compact size) such that they **may** be expected to operate at a different FEI range than other fan types. Additional information on typical duct connections is also provided **below**.

3.1.3.1 centrifugal housed fan radial-flow fan

fan with a centrifugal or radial impeller in which airflow exits into a housing that is generally scroll shaped to direct the air through a single fan outlet

Note_1_to_entry: Inlets and outlets can optionally be ducted.

3.1.3.2 centrifugal inline fan

fan with a centrifugal or mixed flow impeller in which airflow enters axially at the fan inlet and the housing redirects radial airflow from the impeller to exit the fan in an axial direction

Note_1_to_entry: Inlets and outlets can optionally be ducted.

3.1.3.3 centrifugal unhooded fan plenum fan

fan with a centrifugal impeller in which airflow enters through a panel and discharges into free space

Note_1_to_entry: Outlets are not ducted.

Note_2_to_entry: This fan type also includes fans designed for use in fan arrays that have partition walls separating the fan from other fans in the array.

3.1.3.4 power roof ventilator (PRV) PRV

fan with an internal motor and a housing to prevent precipitation from entering the building

Note_1_to_entry: It has a base designed to fit over a roof or wall opening, usually by means of a roof curb.