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Fans — Efficiency classification for fans —

Part 4: Driven fans at maximum operating speed

Ventilateurs — Classification du rendement des ventilateurs — Partie 4: Ventilateurs entraînés à vitesse maximale de fonctionnement

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Foreword

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

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This first edition of ISO 12759-4, together with ISO 12759-1, ISO 12759-2, ISO 12759-3, ISO 12759-5[1)] and ISO 12759-6[2)], cancels and replaces ISO 12759:2010, which has been technically revised. It also incorporates the Amendment ISO 12759:2010/Amd.1:2013.

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.

1) Under preparation. Stage at the time of publication: ISO/DIS 12759-5:2019.

2) Under preparation. Stage at the time of publication: ISO/CD 12759-6:2019.

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Introduction

The last decade has seen an escalation in the price and an increasing recognition of the finite life of many of the fossil fuels currently used. There is also a belief by many that climatic change is due to increasing levels of carbon dioxide in the atmosphere. This has led to many nations reviewing methods of energy generation and usage.

To maintain economic growth there is therefore a need to promote energy efficiency. This requires better selection of equipment by users and thus better design of this equipment by manufacturers.

Fans of all types are used for ventilation, air conditioning, process engineering – drying, pneumatic conveying – combustion air supply and agriculture. Indeed, the energy use of fans has been calculated to account for nearly 20 % of the global electricity usage.

The fan industry is global in nature, with a considerable degree of exporting and licensing. To ensure that the definitive fan performance characteristics are common throughout the world, a series of standards has been developed. It is the belief of the industry that there is now a need for minimum efficiency standards to be recognised. 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 could be reviewed and increased over time.

This document can be used by legislators or regulatory bodies for defining future energy-saving targets.

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Fans — Efficiency classification for fans —

Part 4: Driven fans at maximum operating speed

1 Scope

This document establishes a system for the classification of fan efficiency for all fan types driven by motors of nominal rating 0,125 kW and above. It applies to driven fans only, but not to the system (finished original equipment manufacturer's product, for example box fans and roof fans or ventilation system) in which they might be installed. This document describes a number of different procedures to classify the efficiency of a fan or to apply a minimum efficiency limit (MEL). Those procedures are described in:

— ISO 12759-3;

— this document (ISO 12759-4);

— ISO 12759-5;

— ISO 12759-6.

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There is no method described to compare these classifications and MEL's.

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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 13348:2007, *Industrial fans — Tolerances, methods of conversion and technical data presentation*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
fan
rotary-bladed machine that 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 to entry: Fans are defined according to their installation category, function, fluid path and operating conditions (see ISO 13349).

[SOURCE: ISO 13349:2010, 3.1.1, — Notes to entry 1 and 3 were deleted.]

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3.2
fan size
nominal diameter of the impeller

3.3
drive
mechanism used to power the fan which includes the motor, belt, couplings, chains, transmission and VFDs

EXAMPLE Transmission drive and motor drive.

3.4
driven fan
impeller fitted to or connected to a motor, with or without a drive mechanism, housing or means of variable speed drive

Note 1 to entry: See Figure 1.

3.5
air
working fluid for tests with standardized airways shall be atmospheric air

[SOURCE: ISO 5801:2017, 3.1]

3.6
installation category A
installation with free inlet and free outlet with a partition

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[SOURCE: ISO 13349:2010, 3.4.1, modified — References to ISO 5801 and ISO 5802 were deleted.]

3.7
installation category B
installation with free inlet and ducted outlet

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[SOURCE: ISO 13349:2010, 3.4.2, modified — References to ISO 5801 and ISO 5802 were deleted.]

3.8
installation category C
installation with ducted inlet and free outlet

[SOURCE: ISO 13349:2010, 3.4.3, modified — References to ISO 5801 and ISO 5802 were deleted.]

3.9
installation category D
installation with ducted inlet and ducted outlet

[SOURCE: ISO 13349:2010, 3.4.4, modified — References to ISO 5801 and ISO 5802 were deleted.]

3.10
density at fan inlet
ρ_1
fluid density calculated from the absolute pressure and the static temperature at the fan inlet

3.11
fan pressure
p_f
difference between the stagnation pressure at the fan outlet and the stagnation pressure at the fan inlet

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3.12
mass flow rate
q_m
mean value, over time, of the mass of air which passes through the specified airway cross-section per unit of time

3.13
inlet volume flow rate
q_{v1}
mass flow rate at the inlet divided by the corresponding mean value, over time, of the average density at the inlet

3.14
fan work per unit mass
W_m
increase in mechanical energy per unit mass of fluid passing through the fan

3.15
compressibility coefficient
k_p
ratio of the mechanical work done by the fan on the air to the work that would be done on an incompressible fluid with the same mass flow, inlet density and pressure ratio

3.16
fan air power
P_u
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conventional output power which is the product of the mass flow rate and the fan work per unit mass, or the product of the inlet volume flow rate, the compressibility coefficient and the fan pressure
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3.17
fan static air power
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P_{us}
conventional output power which is the product of the mass flow rate and the fan work per unit mass, or the product of the inlet volume flow rate, the compressibility coefficient and the fan pressure

3.18
impeller power
P_r
mechanical power supplied to the fan impeller

[SOURCE: ISO 5801:2017, 3.45]

3.19
fan shaft power
P_a
mechanical power supplied to the fan shaft

[SOURCE: ISO 5801:2017, 3.46, modified — Note 1 to entry was deleted.]

3.20
motor output power
P_o
shaft power output of the motor or other prime mover

[SOURCE: ISO 5801:2017, 3.47]

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3.21
motor input power
P_e
electrical input power supplied at the terminals of an electric motor drive without a variable speed drive

[SOURCE: ISO 5801:2017, 3.48]

3.22
drive/control electrical input power
P_{ed}
power supplied by electrical mains or equivalent energy supply to a motor system

3.23
fan impeller efficiency
η_r
fan air power divided by the impeller power

[SOURCE: ISO 5801:2017, 3.50, modified — References to quantities and formula deleted.]

3.24
fan shaft efficiency
η_a
fan air power divided by the fan shaft power

[SOURCE: ISO 5801:2017, 3.51, modified — References to quantities and formula deleted.]

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3.25
overall efficiency for a fan without a variable speed drive
η_e
fan air power divided by the motor input power for the fan and motor without a variable speed drive

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Note 1 to entry: The efficiency should be referred to the installation category, see Figure 2 and ISO 13349.

Note 2 to entry: For the purposes of this document efficiency should be expressed as a proportion of unity. To obtain a percentage value multiply the efficiency result by 100.

Note 3 to entry: The motor input power as defined in 3.21.

3.26
overall efficiency for a fan with a variable speed drive
η_{ed}
fan air power divided by the motor input power for the fan and motor combination with a variable speed drive

Note 1 to entry: The efficiency should be referred to the installation category, see Figure 2 and ISO 13349.

Note 2 to entry: For the purposes of this document efficiency should be expressed as a proportion of unity. To obtain a percentage value multiply the efficiency result by 100.

Note 3 to entry: The motor input power as defined in 3.22.

3.27
overall static efficiency for a fan without a variable speed drive
η_{es}
fan static air power divided by the motor input power for the fan and motor without a variable speed drive

3.28
overall static efficiency for a fan with a variable speed drive
η_{esd}
fan static air power divided by the motor input power for the fan and motor combination with a variable speed drive

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3.29
optimum efficiency
η_{opt}
maximum efficiency achieved on the fan air characteristic with all operational parameters, except the air system resistance, being fixed

3.30
fan motor efficiency grade
FMEG
efficiency grade for a driven fan

Note 1 to entry: The definitions given in 3.25 to 3.28 shall apply.

4 Symbols

Symbol	Term	Unit
k_p	compressibility coefficient	
N_G	grade number	
P_a	fan shaft power	W
P_e	motor input power	W
P_{ed}	drive/control electrical input power	W
P_o	motor output power	W
P_r	impeller power	W
P_u	fan air power	W
P_{us}	fan static air power	W
p_a	atmospheric pressure	Pa
p_d	dynamic pressure at a point	Pa
p_f	fan pressure	Pa
p_{sf}	fan static pressure	Pa
p_{sg}	absolute stagnation pressure at a point	Pa
q_m	mass flow rate	kg/s
q_{v1}	inlet volume flow rate	m^3/s
W_m	fan work per unit mass	J/kg
η_a	fan shaft efficiency	Expressed as a decimal
η_e	overall efficiency	Expressed as a decimal
η_{ed}	overall efficiency for a fan with VSD	Expressed as a decimal
η_{es}	overall static efficiency	Expressed as a decimal
η_{esd}	overall static efficiency for a fan with VSD	Expressed as a decimal
η_{opt}	optimum efficiency	Expressed as a decimal
η_r	fan impeller efficiency	Expressed as a decimal
ρ_1	density at fan inlet	kg/m^3

NOTE Efficiency in percent (%) divided by 100 equals the efficiency expressed as a decimal.

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5 General information

5.1 General

Fans range from the purpose-built single fan to the series-produced certified ranges manufactured in large quantities. A fan may be a motor attached to a drive system attached to an impeller within an

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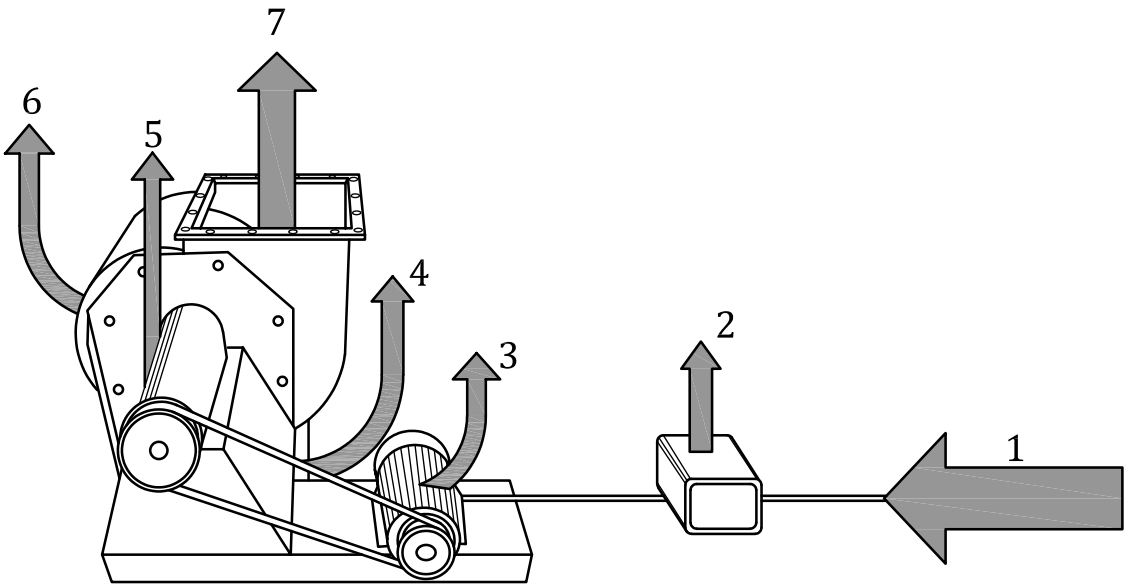
impeller casing, if so supplemented by a volume control such as a variable speed control or guide vanes (driven fan), see Figure 1.

The variation in design has led to efficiency being defined in a number of ways to suit the demands of the fan type and the market place.



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Key

1 electrical input power P_{ed}
2 variable speed device loss (heat)[a]
3 motor losses (heat)
4 belt losses (heat)
5 bearing losses (heat)
6 impeller and casing aerodynamic losses (heat)
7 volume flow and pressure P_u (air power)

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[a] The variable speed device might or might not be fitted. See Clause 6.

Figure 1 — Example of a driven fan showing power losses

5.2 Use of installation categories

Fan efficiency ratings are frequently specific to each standardised installation category.

When a fan is designed for a single installation category, its rated efficiency grade shall refer to that particular installation category, and this shall be clearly identified.

When a fan is suitable for use with different installation categories, the fan efficiency grade shall be based on the efficiency ratings referring to the most suitable installation category.

To determine the operating point of the fan, four installation categories are considered, see Figure 2. For details of the required test methods refer to the following subclauses of ISO 5801:

— category A installations – ISO 5801:2017, 6.1;

— category B installations – ISO 5801:2017, 6.2;

— category C installations – ISO 5801:2017, 6.3;

— category D installations – ISO 5801:2017, 6.4.

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