INTERNATIONAL STANDARD

ISO 16494-1

First edition
2022-06

Heat recovery ventilators and energy recovery ventilators — Method of test for performance —

Part 1:
Development of metrics for evaluation of energy related performance

Ventilateurs-récupérateurs de chaleur et ventilateurs-récupérateurs d'énergie — Méthode d'essai des performances —

Partie 1: Développement de paramètres pour l'évaluation des performances énergétiques

Reference number
ISO 16494-1:2022(E)

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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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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 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps.*

This first edition of ISO 16494-1 cancels and replaces the first edition (ISO 16494:2014), which has been technically revised.

The main changes are as follows:

— consistency with terms' definition between similar group of ISO standards (ERV and HRV);

— keep editorial rules of ISO/IEC Directives Part 2 (2021);

— general test requirements, chapter 5, was added;

— test condition, T8, was added in Table 1;

— maximum variations of individual readings from specified test conditions in Table F.2 was deleted.

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.

Heat recovery ventilators and energy recovery ventilators — Method of test for performance —

Part 1: Development of metrics for evaluation of energy related performance

1 Scope

This document specifies a method of testing the ventilation and energy related performance of heat recovery ventilators (HRVs) and energy recovery ventilators (ERVs) that do not contain any supplemental heating (except for defrost), cooling, humidification, or dehumidification components.

Exchanger types of HRVs and ERVs are

a) fixed-plate exchangers (also known as recuperators),

b) rotary exchangers, including heat wheels and total energy wheels (also known as regenerators), and

c) heat pipe exchangers using a heat transfer medium, excluding those using mechanical pumping,

This document does not provide a method for measuring the response of exchangers to the formation of frost.

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 3966, *Measurement of fluid flow in closed conduits — Velocity area method using Pitot static tubes*

ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

ISO 5801, *Fans — Performance testing using standardized airways*

ISO 13253, *Ducted air-conditioners and air-to-air heat pumps — Testing and rating for performance*

ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

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 https://www.electropedia.org/

3.1
coefficient of energy
COE
C_{COE}
total exchanged energy between the airstreams plus the *power value of moving air* (3.22), divided by the power input

Note 1 to entry: The formula for determining the coefficient of energy (C_{COE}) is given in 9.6.

3.2
duct
insulated or uninsulated closed passage for air that is installed as part of the ventilation system in lengths determined by the needs of application, and is separate, prior to installation from exterior terminations such as weather hoods

3.3
ducted ventilator
heat recovery ventilator or energy recovery ventilator which is intended for connection of ducts to one or more of the airflow inlets or outlets and intended to address a range of static pressure differentials from the duct(s)

3.4
effective work
EW
W_{EW}
total exchanged energy between the airstreams plus the power value of moving air minus the power input

Note 1 to entry: The formula for determining the effective work (W_{EW}) is given in 9.7.

Note 2 to entry: Effective work is expressed in W.

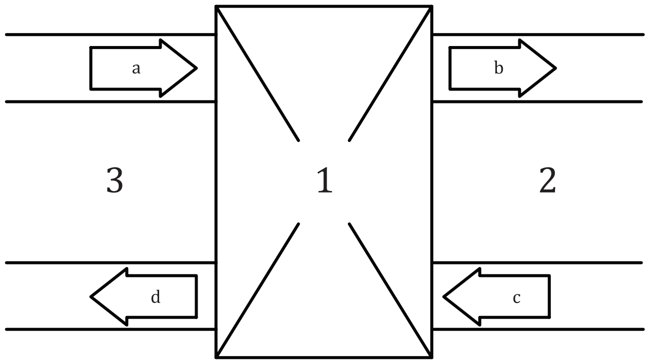
3.5
energy recovery ventilator
ERV
ventilator which is designed to transfer both heat and moisture between two isolated airstreams

3.6
entering exhaust air
exhaust air inlet
return airflow
RA
indoor air entering the ventilator

Note 1 to entry: Indicated in Figure 1 as footnote c.

3.7
entering supply air
supply air inlet
outdoor airflow
OA
outside air entering the ventilator

Note 1 to entry: Indicated in Figure 1 as footnote a.



Key

1 ventilator
2 indoor side
3 outdoor side

[a] Entering supply air (OA).
[b] Leaving supply air (SA).
[c] Entering exhaust air (RA).
[d] Leaving exhaust air (EA).

Figure 1 — Schematic numbering of airflows for heat and energy recovery ventilators

3.8
external static pressure difference
external static pressure difference between inlet and outlet of an air stream or vi versa and is calculated as an absolute value

Note 1 to entry: The formula for absolute value is described in 6.2.2.1.

3.9
fixed-plate exchanger
exchanger with multiple alternate airflow channels, separated by a heat or heat and water vapor transfer plate(s) and connected to supply and exhaust airstreams

3.10
fresh air mass flow rate
$\dot{m}_2$
supply-mass flowrate of dry air at station 2

3.11
gross effectiveness
measured effectiveness, not adjusted for leakage, motor heat gain, or heat transfer through the unit casing

Note 1 to entry: The sensible, latent, or total gross effectiveness of an HRV or ERV, at equal airflows, is described in 9.5.

3.12
heat pipe exchanger
exchanger with an array of finned and sealed tubes that are placed in side-by-side supply and exhaust airstreams, which may include an internal wick structure in each tube and filled with a heat transfer medium

Note 1 to entry: thermosiphon exchangers are a subset (or type) of heat pipe exchanger in which the heat transfer medium moves by gravitational forces only.

3.13
heat recovery ventilator
HRV
ventilator which is designed to transfer only heat between two isolated airstreams

3.14
leaving exhaust air
exhaust air outlet
exhaust airflow
EA
indoor air after passing through the ventilator

Note 1 to entry: Indicated in Figure 1 as footnote d.

3.15
leaving supply air
supply air outlet
supply airflow
SA
outside air after passing through the ventilator

Note 1 to entry: Indicated in Figure 1 as footnote b.

3.16
maximum rated airflow
largest leaving supply and entering exhaust airflows, specified by the manufacturer, at which an airflow test is performed

Note 1 to entry: For ventilators with speed control devices, different maximum rated airflows may be defined for each speed control setting at which the test is performed.

3.17
minimum rated airflow
smallest leaving supply and entering exhaust airflows, specified by the manufacturer, at which an airflow test is performed

Note 1 to entry: For ventilators with speed control devices, different minimum rated airflows may be defined for each speed control setting at which the test is performed.

3.18
model-specific exterior termination system
weather hoods, fittings and through-wall penetrations designed by the ventilator manufacturer specifically for installation with a specific model of ventilator, that comprise the complete passageway connecting the ventilators outside air inlet and/or exhaust air outlet to the ventilator

3.19
net supply airflow
$Q_{2,net}$
portion of the leaving supply airflow that originated as entering supply airflow

Note 1 to entry: The net supply airflow is represented by the variable $Q_{2,net}$ measured in m^3/s.

Note 2 to entry: The formulae for determining net supply airflow are given in 9.4.1 (ducted units) and 9.4.2 (unducted units).

3.20
net supply airflow ratio
ratio determined by dividing net supply airflow by supply airflow

Note 1 to entry: Expressed as a percentage and described in 9.4.1 (see Formula (3)).

3.21
net supply mass flow rate
$\dot{m}_{2,\mathrm{net}}$
portion of the supply mass airflow rate at station 2 that originated as supply mass flow rate at station 2, accounting for R_{UEATR}

Note 1 to entry: See Formula (9) and Formula (13)

3.22
power value of moving air
P_{vma}
rate of pressure energy and kinetic energy of the air delivered by the ventilator

Note 1 to entry: The formula that determines the power value of moving air is given in 9.6.1.

Note 2 to entry: Power value of moving air is expressed in W for P_{vma}. (see Formula (10)).

3.23
rating points
sets of supply and exhaust airflows, static pressures at inlets and outlets, and speed control setting, achieved during the airflow performance measurement, at which thermal performance tests (and exhaust air transfer tests, if applicable) are performed

3.24
rotary exchanger
exchanger with porous discs, fabricated from materials with heat or heat and water vapour retention capacity, that are regenerated by collocated supply and exhaust airstreams

3.25
speed control device
device incorporated into the ventilator which controls the speed of the fan

3.26
station
location in the test apparatus at which conditions such as temperature, humidity, pressure, or airflows are measured

Note 1 to entry: Indicated in Figure 1 as footnotes a, b, c and d.

3.27
standard air
dry air with a density of 1,204 kg/m^3 and a dynamic viscosity of 1,824 7 × 10^{-5} kg/(m·s)

Note 1 to entry: These conditions approximate dry air at 20 °C and 101,325 kPa absolute.

3.28
static pressure differential
static pressure at supply outlet less the static pressure at exhaust inlet

Note 1 to entry: a positive pressure differential occurs when the static pressure at *station* (3.26) 2 is higher than the static pressure at station 3. A negative pressure differential occurs when the static pressure at station 2 is lower than the static pressure at station 3.

3.29
thermal performance measurement
test procedures which measure the temperature and humidity of the supply air when a ventilator is operating with the outside air and exhaust air at specific psychrometric conditions

3.30
unducted ventilator
heat recovery ventilator or energy recovery ventilator which is not intended for connection of ducts to any of the airflow inlets or outlets except for model-specific exterior termination systems as defined in 3.18

3.31
unit exhaust air transfer ratio
UEATR
R_{UEATR}
tracer gas concentration difference between the *leaving supply air* (3.15) and the *entering supply air* (3.7) divided by the tracer gas concentration difference between the *entering exhaust air* (3.6) and the *entering supply air* (3.7), at a specified airflow

Note 1 to entry: The formula for R_{UEATR} is given in 9.3.

3.32
ventilator
self-contained unit that includes fans to move air through the heat/energy exchanger

4 Symbols and abbreviated terms

4.1 Symbols

Symbol	Definition	Units
C_1	Tracer gas concentration at station 1	µmol/mol
C_2	Tracer gas concentration at station 2	µmol/mol
C_3	Tracer gas concentration at station 3	µmol/mol
C_{in}	Tracer gas concentration (indoor type)	µmol/mol
C_{out}	Tracer gas concentration (rooftop type)	µmol/mol
C_{back}	Tracer gas concentration (thru-wall type)	µmol/mol
$C_{chamber,i,0}$	Tracer gas concentration in the test chamber at time zero under attempt i^{th}	µmol/mol
$C_{chamber,i,ti,j}$	Tracer gas concentration in the test chamber at attempt i^{th} under time t of j^{th}	µmol/mol
C_{COE}	Coefficient of energy (COE)	-
c_{p1}	Specific heat of dry air at station 1	kJ/(kg·K)
c_{p2}	Specific heat of dry air at station 2	kJ/(kg·K)
h_1	Enthalpy of the air at station 1	kJ/kg of dry air
h_2	Enthalpy of the air at station 2	kJ/kg of dry air
h_3	Enthalpy of the air at station 3	kJ/kg of dry air
$\dot{m}_2$	Mass flow rate of dry air at station 2	kg/s
$\dot{m}_{2,net}$	Net mass flow rate of dry air at station 2	kg/s
P_{aux}	Power input to any other electrical components in the ventilator	W
P_{em}	Power input to all electric motors in the ventilator	W
P_{in}	Power input to ventilator	W
P_{vma}	Power value of moving air	J/s or W
p_{si}	Static pressures at station i (i=1,2,3,4)	Pa
p_{vi}	Velocity pressure at station i (i=1,2,3,4)	Pa
Q	Airflows	m^3/s

Symbol	Definition	Units
Q_1	Average of the three calculated overall airflow rates with the unit under test in operation as described in B.2.1.1 and B.2.1.2; or supply airflow	m^3/s
Q_2	Average of the three calculated natural airflow rates of the test chamber with the ventilator removed as described in B.2.2.1 and B.2.2.2; or supply airflow	m^3/s
$Q_{1,2}$	Average of the three points with each three times calculated overall airflow rates with the unit under test in operation as described in B.2.1.1 and B.2.1.2	m^3/s
$Q_{i,j}$	Airflow rate calculated using the data from a test at attempt ith under time t of jth as described in B.2.1.1, B.2.1.2, B.2.2.1 and B.2.2.2	m^3/s
$Q_{2,\text{net}}$	Net supply airflow	m^3/s
R_{NSAR}	Net supply airflow ratio (NSAR)	%
R_{UEATR}	Unit exhaust air transfer ratio (UEATR)	%
T_1	Temperature of the entering supply air at station 1 (dry bulb)	°C or K
T_2	Temperature of the leaving supply air at station 2 (dry bulb)	°C or K
T_3	Temperature of the entering exhaust air at station 3 (dry bulb)	°C or K
T_a	Ambient temperature	°C or K
T_{LAB}	Temperature lab ambient	°C or K
$T_{\text{LAB,AVE}}$	Temperature lab ambient, average	°C or K
$T_{\text{LAB,MAX}}$	Temperature lab ambient, maximum	°C or K
$T_{\text{WB},i}$	Ambient temperature at station *i* (wet bulb) (*i*=1,2,3)	°C or K
t	Elapsed time since the start of test unit operation	s
V_c	Air volume in the test chamber	m^3
v_2	Air velocity at PL.2 (See Figure G.1)	m/s
W_{EW}	Effective work	W
x	Dry bulb temperature (for sensible effectiveness); or absolute humidity ratio (for latent effectiveness); or total enthalpy (for total effectiveness).	°C kg water/kg dry air kJ/kg
v_s	Specific volume of the supply air (See Formula (10))	m^3/kg
ε	Effectiveness	1
$\Delta p_{s,\text{ext}}$	External static pressure difference	Pa

4.2 Subscripts

Subscript		
a	ambient	
AVE	average	
BAR	barometric pressure	
chamber	test chamber	
I	in chamber	
i	*i*th attempt of test	
j	*j*th of test time	
o	in outdoor air	
LAB	lab ambient	
WB	wet bulb	