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Thermal performance of buildings — Determination of air permeability of buildings — Fan pressurization method

Performance thermique des bâtiments — Détermination de la perméabilité à l'air des bâtiments — Méthode de pressurisation par ventilateur

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Foreword

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The committee responsible for this document is ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

This third edition cancels and replaces the second edition (ISO 9972:2006), which has been technically revised.

Introduction

The fan-pressurization method is intended to characterize the air permeability of the building envelope or parts thereof. It can be used, for example,

a) to measure the air permeability of a building or part thereof for compliance with a design air-tightness specification,

b) to compare the relative air permeability of several similar buildings or parts of buildings, and

c) to determine the air-leakage reduction resulting from individual retrofit measures applied incrementally to an existing building or part of building.

The fan pressurization method does not measure the air infiltration rate of a building. The results of this method can be used to estimate the air infiltration rate and resulted heat load by means of calculation.

Other methods, like tracer gas, are applicable when it is desired to obtain a direct measurement of the air infiltration rate. A single tracer gas measurement, however, gives limited information on the performance of ventilation and infiltration of buildings.

The fan-pressurization method applies to measurements of air flow through the construction from outside to inside or vice versa. It does not apply to air flow measurements from outside through the construction and back to outside.

The proper use of this International Standard requires knowledge of the principles of air flow and pressure measurements. Ideal conditions for the test described in this International Standard are small temperature differences and low wind speeds. For tests conducted in the field, it needs to be recognized that field conditions can be less than ideal. Nevertheless, strong winds and large indoor-outdoor temperature differences are to be avoided.

Thermal performance of buildings — Determination of air permeability of buildings — Fan pressurization method

1 Scope

This International Standard is intended for the measurement of the air permeability of buildings or parts of buildings in the field. It specifies the use of mechanical pressurization or depressurization of a building or part of a building. It describes the measurement of the resulting air flow rates over a range of indoor-outdoor static pressure differences.

This International Standard is intended for the measurement of the air leakage of building envelopes of single-zone buildings. For the purpose of this International Standard, many multi-zone buildings can be treated as single-zone buildings by opening interior doors or by inducing equal pressures in adjacent zones.

International Standard does not address evaluation of air permeability of individual components.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7345, *Thermal insulation — Physical quantities and definitions*

3 Terms, definitions, and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345 and the following apply.

3.1.1
air leakage rate
air flow rate across the building envelope

Note 1 to entry: This movement includes flow through joints, cracks, and porous surfaces, or a combination thereof, induced by the air-moving equipment used in this International Standard (see Clause 4).

3.1.2
building envelope
boundary or barrier separating the inside of the building or part of the building subject to the test from the outside environment or another building or another part of the building

3.1.3
air change rate
air leakage rate per internal volume across the building envelope

3.1.4
air permeability
air leakage rate per the envelope area across the building envelope

3.1.5
specific leakage rate
<envelope> air leakage rate per the envelope area across the building envelope at the reference pressure difference

3.1.6
specific leakage rate
<floor> air leakage rate per net floor area across the building envelope at the reference pressure difference

3.1.7
effective leakage area
leakage area calculated at the test reference pressure differences across the building envelope

3.1.8
specific effective leakage area
<envelope> leakage area per the envelope area across the building envelope at the reference pressure difference

3.1.9
specific effective leakage area
<floor> leakage area per net floor area across the building envelope at the reference pressure difference

3.1.10
to close an opening
to set an opening in close position using the closing device present on the opening without additionally increasing the airtightness of the opening

Note 1 to entry: If there is no way to close the opening (i.e. without closing device), it remains open.

3.1.11
to seal an opening
to make an opening hermetic by any appropriate means (adhesive, inflatable balloon, stopper, etc.)

3.2 Symbols

Symbol	Quantity	Unit
A_E	envelope area	m^2
A_F	floor area	m^2
ELA_{pr}	effective leakage area at the reference pressure difference	m^2
ELA_{Epr}	specific effective leakage area per the building envelope area at the reference pressure difference	m^2/ m^2
ELA_{Fpr}	specific effective leakage area per the floor area at the reference pressure difference	m^2/ m^2
C_{env}	air flow coefficient	$m^3/(h·Pa^n)$
C_L	air leakage coefficient	$m^3/(h·Pa^n)$
n_{pr}	air change rate at the reference pressure difference	h^{-1}
p	pressure	Pa
p_{bar}	uncorrected barometric pressure	Pa
p_v	partial water vapour pressure of water	Pa
p_{vs}	saturation vapour pressure of water	Pa
q_{50}	air leakage rate at 50 Pa	m^3/h
q_{Epr}	specific leakage rate per the building envelope area at the reference pressure difference across the envelope	$m^3/(h·m^2)$
q_{Fpr}	specific leakage rate per the floor area at the reference pressure difference across the envelope	$m^3/(h·m^2)$
q_m	measured air flow rate	m^3/h
q_{pr}	air leakage rate at the reference pressure difference	m^3/h
q_r	readings of air flow rate	m^3/h
V	internal volume	m^3
Δp	induced pressure difference	Pa
Δp_0	zero-flow pressure difference (average)	Pa
$\Delta p_{0,1}$; $\Delta p_{0,2}$	zero-flow pressure difference before and after the test (air moving equipment closed)	Pa
Δp_{0+}; Δp_{0-}	average of the positive and negative values of zero-flow pressure difference (+ and – mean positive pressure and negative pressure across the envelope respectively)	Pa
Δp_m	measured pressure difference	Pa
Δp_r	reference pressure difference	Pa
φ	relative humidity	—
T_0	absolute temperature at standard conditions	K
T_e	external air absolute temperature	K
T_{int}	internal air absolute temperature	K
θ	Celsius temperature	°C
ρ	air density	kg/m^3
ρ_0	air density at standard conditions	kg/m^3
ρ_e	external air density	kg/m^3
ρ_{int}	internal air density	kg/m^3

4 Apparatus

4.1 General

The following description of apparatus is general in nature. Any arrangement of equipment using the same principles and capable of performing the test procedure within the allowable tolerances is permitted. Examples of equipment configurations commonly used are indicated in Annex A.

Periodic calibration of the measurement system, used in this test method, according to manufacturer specifications or to standardized quality insurance systems is required.

4.2 Equipment

4.2.1 Air-moving equipment

Device that is capable of inducing a specific range of positive and negative pressure differences across the building envelope or part thereof. The system shall provide a constant air flow at each pressure difference for the period required to obtain readings of air flow rate.

4.2.2 Pressure-measuring device

Instrument capable of measuring pressure differences with an accuracy of ±1 Pa in the range of 0 Pa to 100 Pa.

4.2.3 Air flow rate measuring system

Device capable of measuring air flow rate within ±7 % of the reading.

Care shall be taken if the principle underlying the measurement of volumetric flow rate is an orifice. The reading of the air flow rate shall be corrected according to air density [see Formula (2)].

4.2.4 Temperature-measuring device

Instrument capable of measuring temperature to an accuracy of ±0,5 K.

5 Measurement procedure

5.1 Measurement conditions

5.1.1 General

There are two modes for this measurement procedure: depressurization or pressurization of a building or part of a building. Regardless of which mode is used, the air leakage of building envelope can be measured. The accuracy of this measurement procedure is largely dependent on the instrumentation and apparatus used and on the ambient conditions under which the data are taken.

NOTE 1 Pressurization means that the pressure inside the building is higher than outside. Depressurization means that the pressure inside the building is lower than outside.

NOTE 2 If the product of the indoor/outdoor air temperature difference, expressed in Kelvin, multiplied by the height, expressed in metres, of the building or measured part of the building gives a result greater than 250 mK, it is unlikely that a satisfactory zero-flow pressure difference can be obtained (see 5.3.3).

NOTE 3 If the wind speed near the ground exceeds 3 m/s or the meteorological wind speed exceeds 6 m/s or reaches 3 on the Beaufort scale, it is unlikely that a satisfactory zero-flow pressure difference can be obtained (see 5.3.3).

5.1.2 Measured extent

The extent of the building or part of the building measured depends on the purpose of the test and is defined as follows.

a) Normally, the part of the building measured includes all deliberately conditioned rooms (i.e. rooms that are intended to be directly or indirectly heated, cooled, and/or ventilated as a whole).

b) If the aim of the measurement is compliance with the air-tightness specification of a building code or standard and the measured extent is defined in this code or standard, the measured extent is defined as in this code or standard.

c) If the aim of the measurement is compliance with the air-tightness specification of a building code or standard and the measured extent is not defined in this code or standard, the measured extent is defined as in a).

d) In special cases, the measured extent can be defined in agreement with the client.

Individual parts of a building can be measured separately, e.g. in apartment buildings, each apartment can be measured individually. However, interpretation of results shall consider that air leakage measured in this way can include flow through leaks to adjacent parts of the building.

NOTE 1 It is possible that an apartment building meets air-tightness requirements, but that one or more individual apartments do not.

NOTE 2 Good practice requires measuring pressures induced in adjoining spaces, such as the attic and basement or adjacent apartments, since air flow into or out of these spaces can be induced by the test method.

5.1.3 Time of measurement

The measurement can take place only after the completion of the envelope of the building or part of the building to be tested.

NOTE A preliminary air permeability measurement of the air barrier of the building under construction can allow leakages to be repaired more easily than after the building has been completed.

5.2 Preparation

5.2.1 Building preparation methods

This International Standard describes several types of test methods depending on the purpose. The preparation of the building depends on the test method selected.

a) Method 1 is the test of the building in use where the natural ventilation opening being closed and the whole building mechanical ventilation or air conditioning opening being sealed.

b) Method 2 is the test of the building envelope where all the intentional openings being sealed, the doors, windows, and trapdoors being closed.

c) Method 3 is the test of the building for a specific purpose, the treatment of the intentional openings being adapted to this purpose according to the standard or policy in each country.

NOTE The choice of the method depends on the purpose of the test. For example, the method 1 could be used in the context of clean rooms, method 2 to compare different construction techniques, and method 3, for compliance with the air-tightness specification of a building code or standard, in the context of calculation of energy performance of buildings.

5.2.2 Heating, ventilation and air conditioning systems and other building equipment

All devices taking air from or rejecting air to outside, which are not used for the intentional (de-) pressurization according to 5.2.5, shall be turned off, e.g. heating systems with indoor air intake,

mechanical ventilation and air conditioning systems, kitchen hoods, tumble-dryers, etc. Water traps in plumbing systems shall be filled with water or sealed.

Open fireplaces shall be cleared of ashes.

Take measures to avoid exhaust hazards from heating systems. Take into account heating sources in adjacent apartments.

5.2.3 Intentional openings in the envelope

For the purpose of method 1:

Close all windows, doors and trapdoors in the envelope.

Ventilation openings in the envelope for natural ventilation shall be closed.

Openings for whole building mechanical ventilation or air conditioning shall be sealed, i.e. to seal

a) either the main ducts, between the fan and the building envelope,

b) either all the individual air terminal devices, or

c) the openings to the outside (intakes and exhaust).

Other intentional openings in the envelope including intermittent use mechanical ventilation or air conditioning shall be closed.

Fire-guards and smoke-guards shall be in their normal position of use, e.g. fire-guards and smoke-guards that are usually closed and that open automatically in case of fire remain closed; fire-guards and smoke-guards that are normally open and that close automatically in case of fire remain open.

Openings not intended for ventilation in the envelope, for example, postbox installed at external door or wall, combustion appliance and so on, shall be closed. The cracks in the envelope are excluded.

Do not take any further measures to improve the air-tightness of the building envelope.

For the purpose of method 2:

Close all windows, doors, and trapdoors in the envelope.

Ventilation openings for natural ventilation shall be sealed. Openings for mechanical ventilation or air conditioning shall be sealed as specified for method 1.

All remaining intentional openings in the envelope shall be sealed, except the windows, doors, and trapdoors which remain closed.

For the purpose of method 3:

The intentional openings in the envelope shall be closed, sealed, or open according to the specific purpose of the test (for example, for compliance with the air-tightness specification of a building code or standard).

Openings not intended for ventilation in the envelope shall be closed, sealed, or open according to the specific purpose of the test.

For the purpose of all methods

Make general observations of the condition of the building. Take notes on the windows, doors, opaque walls, roof and floor, position of adjustable openings and any sealing applied to intentional openings.

