INTERNATIONAL STANDARD

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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

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9972 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

This second edition cancels and replaces the first edition (ISO 9972:1996), 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

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;

c) to identify the leakage sources;

d) 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 is suitable for the respective diagnostic purposes. Although the air infiltration and exfiltration cannot be measured directly, the results of this method can also be used to estimate with adequate precision by means of calculation both the mean infiltration through unintended leakages and the mean air flow through intended air flow devices from outside, in relation to the pressure conditions to be expected within the building.

This method does not measure the air-infiltration rate of a building. The results of the fan-pressurization test can be used to estimate the air infiltration by means of calculation. Other methods are applicable when it is desired to obtain a direct measurement of the air infiltration rate. It is better to use the fan-pressurization method for diagnostic purposes and measure the actual infiltration rate with tracer gas methods. A single tracer gas measurement gives limited information on the performance of ventilation and infiltration of buildings.

This 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 from other places within the construction back to outside.

The proper use of this International Standard requires a knowledge of the principles of air flow and pressure measurements. Ideal conditions for the test described in this 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 should 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.

It does not address evaluation of air permeability through individual components.

2 Normative references

The following referenced documents are indispensable for the application 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 6781, *Thermal Insulation — Qualitative detection of thermal irregularities in building envelopes — Infrared method*

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

ISO 13790:2004, *Thermal performance of buildings — Calculation of energy use for space heating and cooling*

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 This movement includes flow through joints, cracks and porous surfaces, or a combination thereof, induced by the air-moving equipment used in this standard (see Clause 4).

3.1.2
internal volume
deliberately heated, cooled or mechanically ventilated space within a building or part of a building subject to the measurement, generally not including the attic space, basement space and attached structures

3.1.3
building envelope
boundary or barrier separating the internal volume subject to the test from the outside environment or another part of the building

3.1.4
air change rate at reference pressure
air leakage rate per internal volume at the reference pressure difference across the building envelope

NOTE The reference pressure is usually 50 Pa.

3.1.5
air permeability
air leakage rate per envelope area at the reference pressure difference across the building envelope

NOTE The reference pressure is usually 50 Pa.

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

NOTE A pressure difference of 50 Pa is the most common.

3.1.7
leakage area
area corresponding to air leakage rate at the reference pressure difference across the building envelope

NOTE A pressure difference of 10 Pa is the most common.

3.1.8
specific leakage area
leakage area per net floor area or envelope area at the test reference pressure difference across the building envelope

3.2 Symbols

Symbol	Quantity	Unit
a_{10}	specific leakage area at 10 Pa	m^2/m^2
A_E	envelope area	m^2
A_F	floor area	m^2
A_L	leakage area	m^2
C_{env}	air flow coefficient	$m^3/(h \cdot Pa^n)$
C_L	air leakage coefficient	$m^3/(h \cdot Pa^n)$
n_{50}	air change rate at 50 Pa	h^{-1}
p	pressure	Pa
p_{bar}	uncorrected barometric pressure	Pa
p_v	partial vapour pressure of water	Pa
p_{vs}	saturation vapour pressure of water	Pa
Q	tracer gas injection rate	m^3/h
q_{50}	air permeability at 50 Pa	m^3/h
q_{a50}	air permeability	

Symbol	Quantity	Unit
q_{env}	air flow rate through the building envelope	m^3/h
$q_{env,s}$	air flow rate through the building envelope	m^3/s
q_{L50}	air leakage rate at 50 Pa	m^3/h
q_m	measured air flow rate	m^3/h
q_{p50}	air permeability at 50 Pa	$m^3/(h \cdot m^2)$
q_{pr}	air leakage rate at a specified reference pressure difference	m^3/h
q_r	readings of air flow rate	m^3/h
V	internal volume	m^3
w_{50}	specific leakage rate at 50 Pa	$m^3/(h \cdot m^2)$
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_m	measured pressure difference	Pa
Δp_r	reference pressure	Pa
Φ	relative humidity	–
T	absolute temperature	K
T_e	external air absolute temperature	K
T_{int}	internal air absolute temperature	K
ρ	air density	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

This includes any 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

This includes any instrument capable of measuring pressure differences with an accuracy of ± 2 Pa in the range of 0 Pa to 100 Pa.

4.2.3 Air flow rate measuring system

This includes any 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 manufacturers' specifications).

4.2.4 Temperature-measuring device

This includes any instrument capable of measuring temperature to an accuracy of ± 1 K.

5 Measurement procedure

5.1 Measurement conditions

5.1.1 General

There are two methods for this measurement procedure: depressurization or pressurization of a building or part of a building. Regardless of which method 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 In general, the measurement result of the depressurization method is larger than that for the pressurization method. However, when air-tightness in the building is high, the test results of both methods are almost equal.

5.1.2 Measured extent

The extent of the building or part of the building measured is defined as follows.

a) Normally, the part of the building measured includes all deliberately conditioned rooms.

b) In special cases, the extent of the part of the building actually to be tested can be defined in agreement with the client.

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 by a standard, the measured extent is defined as in a).

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.

5.1.4 Meteorological conditions

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 m·K, it is unlikely that a satisfactory zero-flow pressure difference can be obtained (see 5.3.3).

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).

5.2 Preparation

5.2.1 General

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

— Method A (test of a building in use):

  The condition of the building envelope should represent its condition during the season in which heating or cooling systems are used.

— Method B (test of the building envelope):

  Any intentional opening in the building envelope shall be closed or sealed as specified in 5.2.2 and 5.2.3.

— Method C (test of the building in use):

  Automatically regulating, externally mounted air transfer devices are sealed, other openings are handled in the same way as for method A.

5.2.2 Building components

Close all intentional exterior openings of the building or part of the building to be tested (windows, doors, fireguard).

For the purpose of methods A and C (building in use), do not take any further measures to improve the air-tightness of the building components (however, see also 5.2.3). For the purpose of method C, all automatically regulating externally mounted air transfer devices are sealed. This is valid for natural supply and exhaust systems, as well as for natural supply and mechanical exhaust systems.

For the purpose of method B (building envelope), all adjustable openings shall be closed and remaining intentional openings shall be sealed.

The entire building or part of the building to be tested shall be configured to respond to pressurization as a single zone.

All interconnecting doors (except for cupboards and closets, which should be closed) in the part of the building to be tested shall be opened so that a uniform pressure is maintained within a range of less than 10 % of the measured inside/outside pressure difference.

NOTE When testing large or complex buildings, this condition becomes increasingly important and can be verified by selected differential pressure measurements between different rooms at the highest pressure contemplated.

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 sealings applied to intentional openings.